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All material should be typed. Any programs submitted must be listed (cassette tapes and discs will not be accepted) and should be accompanied by sufficient documentation to enable their implementation. Please enclose an SAE if you want your manuscript returned, all submissions will be acknowledged. Any published work will be paid for.

All work for consideration should be sent to the Editor at our Charing Cross Road address.

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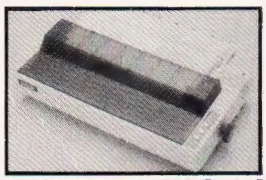

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CONSUMER NEWS

PERSONALLY PORTABLE

Hewlett-Packard have designed a micro for both portability and desk-top use.

Designated the HP-75C, the device measures just 10" by 5" by 1¼" and weighs only 26 ounces. The machine comes complete with 16K of RAM with the ability to be upgraded to 24K with an 8K plug-in memory module. There are also three software module plug-in ports which will accept 8K or 16K ROM modules. Thus, with the 16K plug-in ROM modules, the 48K built-in operating system and 24K of RAM, the HP-75C's maximum memory is 120K.

The keyboard is of standard QWERTY style and a 32 character, LCD display serves as a 'window' on a 96 character line. As well as being able to interface to TVs and monitors, the HP-75C is also able to communicate with a wide range of peripherals and other computers.

Programmable in BASIC, the HP-75C is also capable of operating under special software plug-in packs which provide solutions for specific applications such as finance, real estate, surveying, data analysis and electrical engineering.

For more information on the HP-75C, get in touch with Hewlett-Packard Ltd, Nine Mile Ride, Easthampstead, Wokingham, Berkshire RG11 3LL or 'phone them on 03446-3100.

THE SWEDISH SOLUTION

Designed and developed in Sweden, the Video-Glasses anti-glare screen is now available in the UK providing clarity of the text image as well as reducing unwanted reflected light from the screen by 75%.

The screens can be fitted in seconds and each frame is custom designed to fit the user's particular terminal. Both mesh and frame can be easily removed, cleaned and sprayed with anti-static compound if required.

The anti-glare screens are priced at £16.75, but discounts are promised if more than ten are ordered. For further information contact File Binders Ltd, 153-155 High Street, London SE20 7DS or 'phone 01-659 0190.

BUG BYTES

In the most humblest of tones can we apologise to Bruce Smith for leaving his name off his ATOM FORTH Reviewed article. Also to the rest of you who were no doubt confused by the lack of a Listing 1 and a Table 2, both of which were referred to in the text but were unfortunately missed out.

So, here in their entirety are Listing 1 and Table 2 from ATOM FORTH Reviewed as published in the October issue of *Computing Today*.

```
HEX

CREATE 2/

      18   C,  185  ,  910  ,  F6   ,
      2D0   ,  1F6  ,  1F0  ,  38  C,
      176   ,   76  ,  4C  C,  2842 ,

SMUDGE
```

```
SAVE        EMPTY-BUFFERS
E           H
T           TEXT
X           N
MATCH
```

```
ENTER       LIST        WHERE
PROGRAM     P           D
I           R           S
C           F           TILL
B           DELETE      M
```

And, before we put away the sackcloth and ashes, we had a frantic 'phone call from Alan Pearmain this morning about his article Tandy Array Dump as published in our November issue. Apparently, he made a slight error in the listing of Listing 2. Line 330 should have read:

```
330  V8=INT(V2/256):V9=V2-256*V7
```

The Mini-Calc feature, which seems to have been well received, appears to have mystified several people who cannot get it running. The following lines of BASIC are suggested by the author as the short control program which should be entered after the machine code is loaded. As well as initialising the Mini-Calc routines they will provide a degree of error trapping:

```
    0  ON ERR GOTO 65526
65523  PRINT @1,16,CHR$(27);
65524  PRINT @17,16,"Mini-Calc";
65525  CALL 12736
65526  PRINT @1,16,CHR$(27);
65527  PRINT @16,16,CMD$(ERR)" Error";
65528  GOTO 65525
```

And, yes it has been a bad month, there is a missing DATA item in the VIC Editor program. The value 32 should be inserted on line 940 immediately after the value 31 (a comma should be inserted to separate the two items).

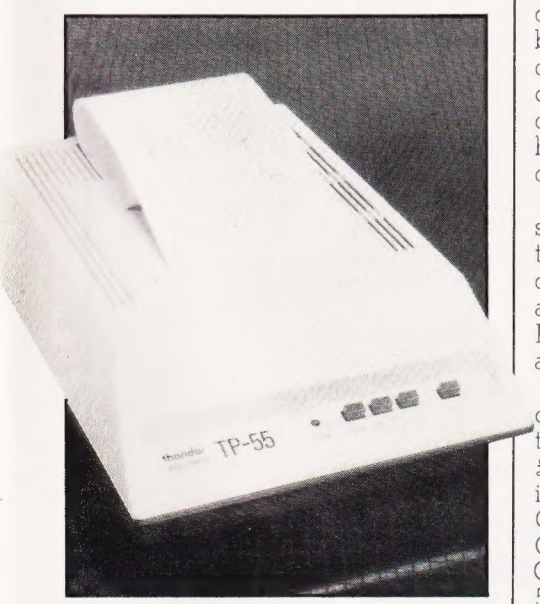
THE MISSING LYNX?

Based on the Z80A microprocessor, the Lynx is a 48K micro with full colour and ultra high resolution graphics.

The Lynx has a professional typewriter keyboard, external power supply and includes an internal speaker. The 48K memory leaves 16K of user available RAM even in high resolution mode and if that's not enough for you, it can be expanded up to 192K. CP/M file management compatibility and an RS232 port come as standard so the machine can be used in any number of business or educational environments, or even as a mainframe computer terminal.

The colour display gives 24 lines of 40 characters, each dot being individually addressable thus providing a resolution of 248 by 256; internal memory expansion can further increase the display to 24 lines of 80 characters and this gives a resolution of 248 by 512. Extensions to the system (to be launched in the new year) include a 5¼" disc drive and a printer.

Priced at £225, you can find out more about the Lynx from Camputers, 33A Bridge Street, Cambridge CA3 4AB. Or you could always telephone them on 0223-315063.



PRINTING PICTURES

The TP55 Video Printer can be connected to any standard video source to provide an instant hard copy record print of any information appearing on the CRT, either as positive or negative prints.

The electrosensitive dot matrix printer prints out on a 5" paper roll at 12 seconds per low resolution picture and 24 seconds per high resolution picture. The device is especially suited to applications with logic analysers and micro terminals with video output.

The TP55 is priced at £753+VAT as is available from Thandar Electronics Ltd, London Road, St Ives, Huntingdon, Cambridge PE17 4HJ. Telephone enquiries can be made on 0480-64646.

LIGHT UP YOUR BBC

Torch Computers have introduced a Z80 based disc system for the BBC Micro allowing the BBC machine to evolve into a powerful business system capable of running CP/M software.

Easily installed with the BBC Micro, the disc pack comes complete with a Z80 processor board with 64K RAM, twin 400K disc drives and the Torch CPN operating system. Two 8K ROMs contain the operating system which has disc and file handling commands built into the firmware.

There are a number of business software packages available with the disc pack including those dealing with accounting, finance and planning. Also available are FORTRAN, Pascal, FORTH, LISP and COBOL.

Completer with full documentation plus system disc, the Torch disc pack is priced at £995+VAT. For further information get in touch with Torch Computers, Abberley House, Great Shelford, Cambridge CB2 5LQ or 'phone 0223-841000.

A CHALLENGE TO SINCLAIR?

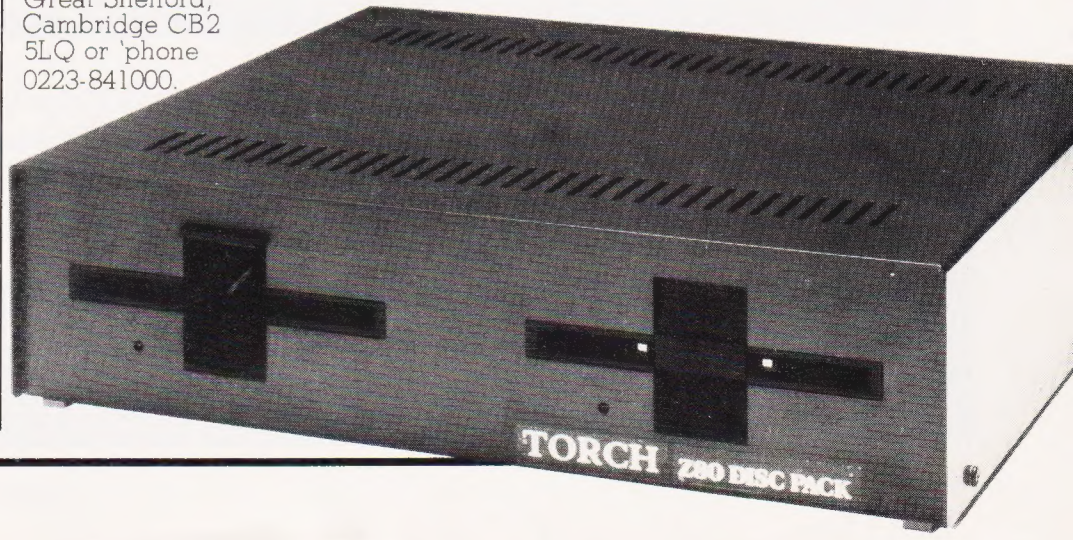
Aimed directly at Clive Sinclair's market is the Oric 1, a micro its manufacturers confidently claim will sell in the region of 50,000+ in the first year of its distribution.

Designed by Tangerine Computer Systems, the Oric 1 comes in two versions: one with 16K RAM at £99 and the other with 48K RAM priced at £169. Both versions are capable of reproducing 16 colours. Complete with a dedicated sound chip, the Oric 1 has a display resolution of 24 rows of 40 characters. The keyboard has 57 moving keys, sound feedback on operation, upper and lower case and no keys have more than two functions.

Both versions have a Centronics printer interface and tape cassette ports and Oric Products say that their own printer, modem and discs will be available soon.

For further information contact Oric Products International Ltd, Coworth Mansion, Coworth Park, London Road, Sunninghill, Ascot, Berks SL5 7SE.

Reports from within the company suggest that it is increasingly unlikely that the Oric will be available in quantity before Christmas as the ULAs (manufactured in the USA) will not start to arrive until December. One hopes that we are not in for another mail-order backlog.



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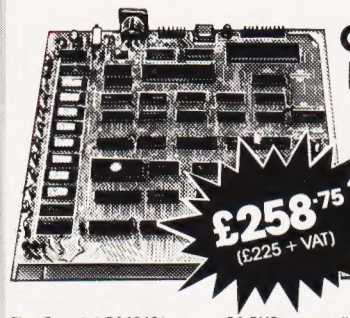

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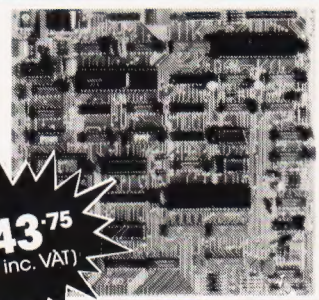

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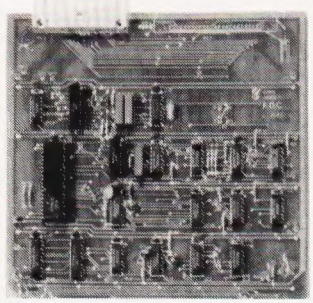

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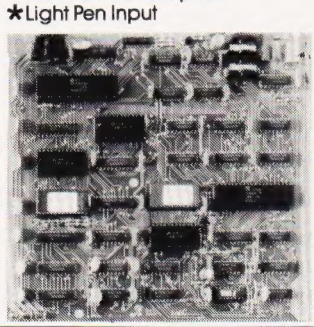

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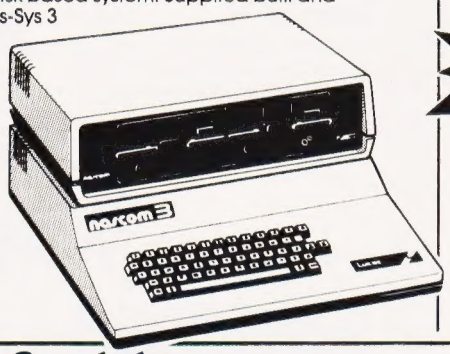

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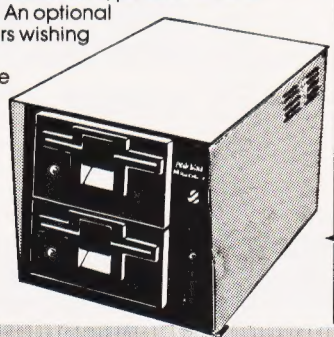

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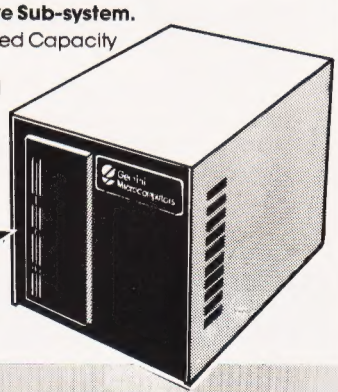

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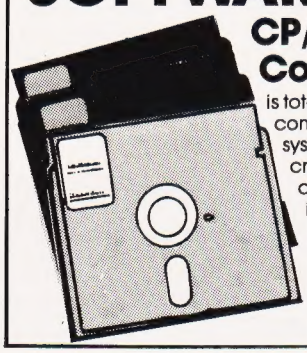

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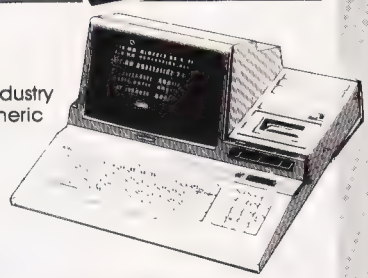

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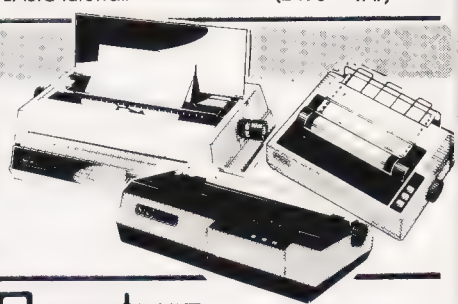

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This combination of hardware and software not only allows printing of the full Sharp character set, but allows a full High Resolution print of the actual screen if used with the Hi-Res graphics option.

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High resolution plotting on your MZ80K down to a resolution of a single dot within a character cell.
A new BASIC is supplied with the following additional commands: LINE, WIPE, G SET, G RESET.

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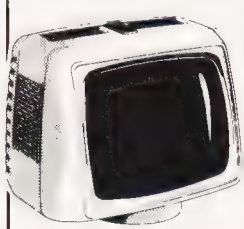

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BUSINESS NEWS

THE WORLD AT YOUR FINGERTIPS

Two micros, designated TMK320 and TMK330, have been announced, both with 64K RAM and 4K of 'shadow' ROM; the shadow ROM is used for start-up diagnostics, a machine code monitor and bootstrap loader.

The only real difference between the two micros is that the model TMK320, priced at £1,995, has two 5¼" floppy disc drives whereas the model TMK330, priced at £3,350, features two 8" floppy disc drives; the TMK320 drives provide 656K and the TMK330 drives provide 2.4M.

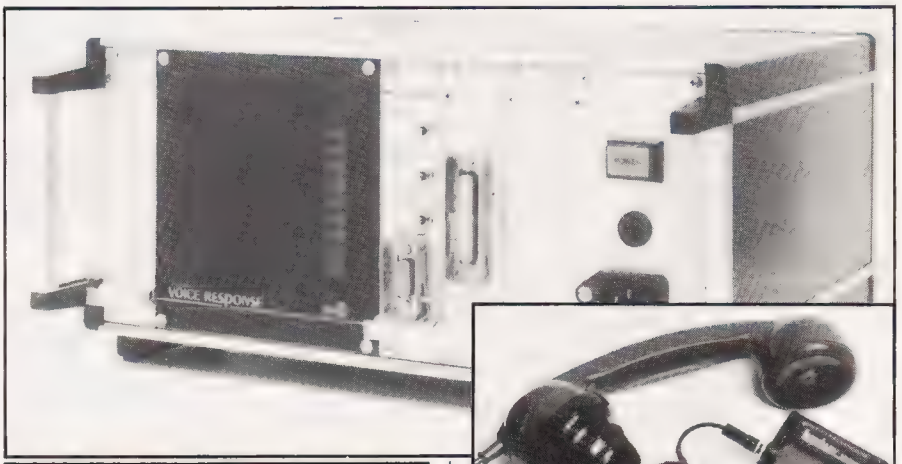
Based on twin Intel 8085 microprocessors and originally designed for the Nippon-Univac partnership, both machines have a phosphor green, anti-glare 12" screen and a professional keyboard with numeric keypad. The bi-directional ports are twin RS232 allowing the user to expand into a multi-user system. Both micros are provided with a 34K SBASIC interpreter and disc operating system which supports the CP/M 2.2 package supplied with the system.

For more details of these machines get in touch with Peripheral Hardware Ltd, Solihull, West Midlands or 'phone 021-745 3033.

THE DISC LIBRARY

It seems as though you really can't keep a good micro down. The Sirius 1 can now be purchased with a Winchester disc actually built into the machine. This unit will offer 10M of hard disc storage while still retaining the original 1.2M floppy disc storage of the standard Sirius system.

The price of the new system is £4,395+VAT. For more information get in touch with ACT (Sirius) Ltd, FREEPOST, Halesowen, West Midlands B63 1BR. Telephone enquiries can be made on 021-501 2284.



DOWN THE LINE

The VR8 Voice Response Unit provides clear, human speech output from existing computers over the dialled telephone network.

The VR8 automatically accepts incoming calls from telephones with multi-frequency tones or standard telephones with pocket-sized Minitone keypads attached, and passes the data to the computer in the usual manner. The VR8's speech facility is activated by commands from the computer and the unit's own host computer can then deliver speech down the line.

Nicknamed 'the chatterbox', you could purchase a trial system involving only one telephone line with six Minitone terminals for less than £3,500; the Minitone devices can be bought separately for £50.

For further information contact Medway Data Ltd, Victoria House, Grover Street, Tunbridge Wells, Kent TN1 2QB or 'phone 0892-4462.

MICRO IN PRINT?

A full function portable micro has been introduced to the UK market from those awfully nice printer people, Epson.

Designated the HX 20, the device comes with 16K RAM which can be expanded up to 20.6K. The operating language is an extended version of Microsoft BASIC.

The HX 20 also includes a LCD display which shows segments of the total screen area which is 255 columns by 255 lines. And as you might have guessed, the HX 20 includes a dot matrix printer capable of outputing 42 lines per minute.

Several options are to be introduced in the future including a display controller which allows

the use of a CRT as a monitor, floppy disc drives and an accoustic coupler for transmitting data over the telephone.

If you'd like more information on the HX 20, contact Epson UK Ltd, Dorland House, 388 High Road, Wembley, Middlesex or 'phone 01-90 0466. How much is the beast, I hear you asking? Well, I was told it would definitely be under £500 — for further details you'll have to get in touch with Epson.

VIEW DATA

Hewlett-Packard have introduced a series of colour graphics terminals which will perform complex functions to off-load graphics calculations from a host computer, and then display the data as multiple views using its zoom and pan facilities.

The HP2700 series of terminals features two models for business, the Model 65 Presentation Graphics workstation and the Model 60 Decision Support workstation, and two models for technical applications, the Model 55 Technical Design terminal and the Model 50 expandable base unit.

There are two application packages, HP Autoplot/2700 and HP Paintbrush/2700, available which enhance the machines' capabilities considerably. HP Autoplot features a menu-driven interface to design a wide range of business charts and flexible graphics text and HP Paintbrush offers electronic sketching from an optional graphics tablet and the local editing of pictures.

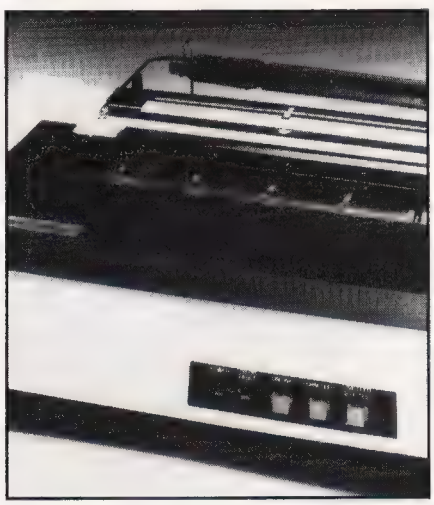
For further information including price, contact Hewlett-Packard Ltd, Nine Mile Ride, Easthampstead, Wokingham, Berkshire RG11 3LL or 'phone 03446-3100.

PRISM PRINT

A printer is now available offering print and graphic quality approaching daisy wheel standards.

Based on the Prism nine-wire printhead, the printer measures only 16" by 11½" by 4½" and weighs 16½ lbs. In print mode the Microprism's throughput is 75 cps of letter quality and 110 cps for data quality. Quality reproduction in graphic mode is ensured by high density (84 by 84 dots per inch) printing.

Priced at £499 + VAT, you can find out more about the Microprism from Communications Accessories & Equipment Ltd, Akeman Street, Tring, Herts HP23 6AJ or by 'phoning 044-282 4011.



IS VICTOR THERE? ▶

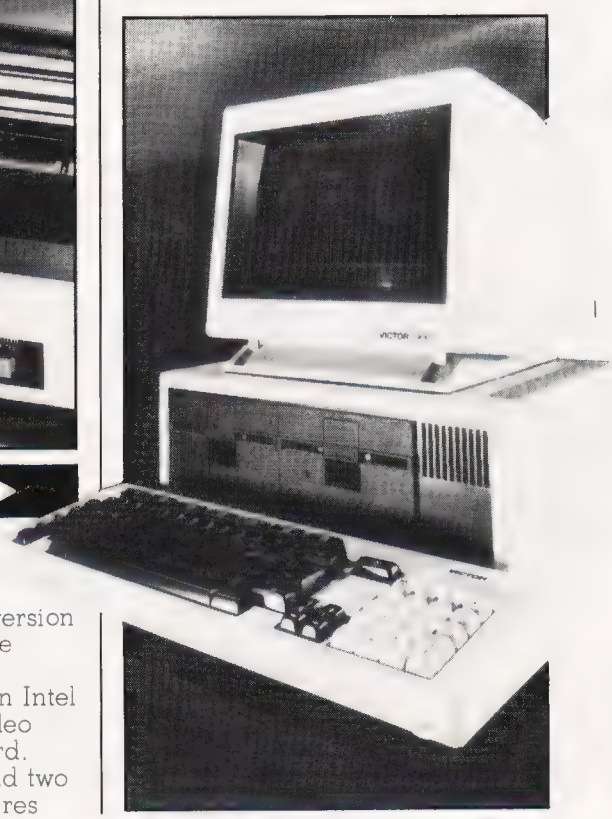
Special offers bound with the introduction of the 16-bit micro, Victor 9000 — a relabelled version of that current best-seller, the Sirius 1.

The Victor 9000 utilises an Intel 8088 processor and has a video display terminal and keyboard. Complete with 128K RAM and two 5¼" disc drives, it also features two RS232 ports, two parallel ports, voice output and a real time clock. The system includes an expansion bus which means that options like a 5¼" Winchester disc unit may be employed.

CP/M-86 and MS-DOS are included as standard, but there are a number of user packages available such as Victor-Calc and Victor-Writer.

Included in the launch price of £2,395+VAT is a suite of accounting packages from TABS, twelve months warranty and a full dealer support. You could also pick up a 25cps Tec Starwriter printer for only £550.

For more information on the Victor 9000 contact DRG Business Machines, 13/14 Lynx Crescent, Winterstoke Road, Weston Super-Mare, Hants or telephone them on 0934-415398.



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FMS 82 (Enhancement to FMS 81)	**£325.00**
Finas (Six module fully integrated accounts program suite)	**£1249.00**

All prices are shown exclusive of P&P and VAT and are subject to change without notice.

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AVC (Hi Res colour graphics)	**£185.00**
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SOFT WARES

OPEN HOUSE

A subsidiary of Keen Computers, Atlantic Software, has been set up to distribute proven and innovative software from both sides of the Atlantic.

The company has identified specific educational end-user needs and will be designing software for key industry and professional needs. Also provided will be an intensive programme of field and distributor service and support.

Typical examples of the type of software they will be introducing varies from an on-site project management control system with wide industrial application to a multi-user mailing package for marketing and direct mail users. A number of other options have also been developed for legal, medical and accounting practices.

For further details of this new software house, contact Atlantic Software Ltd, Minerva House, Spaniel Row, Nottingham or 'phone 0602-412777.

SOFT IN THE HEAD?

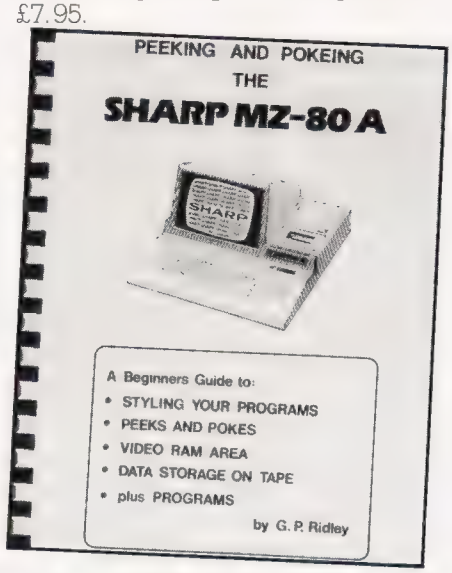
Grundy have announced a whole series of cassette based software to run on the Grundy NewBrain.

Priced at £4.95 are a number of program packages including a freezer allocation/warning program, a card index package ideal for keeping track of birthdays, etc, and language teaching programs for French and German. There are also some program packages priced at £9.95 which include Home Budgeting, Tycoon — a stock exchange gambling game, Quadrax and Space Battle games.

For the business user, the first of a range of software is now available for £25.95. These include Database — an electronic card index and mailing list package, and Monthly Accounts, providing business records and general accounting.

All the packages will be available on CP/M discs early in the new year. For further information contact Grundy Business Systems Ltd, Cambridge Science Park, Milton Road, Cambridge or telephone 0223-350355.

Grundy have also published a NewBrain beginners manual containing 120 pages of colour coded instructions to be used alongside a cassette tape of 22 step-by-step instruction programs. This little package will be priced at £7.95.



BETWEEN THE LINES

Here's a book which could prove invaluable to the beginner or hobbyist wishing to increase their understanding of the Sharp MZ-80A.

Called **PEEKing and POKEing the Sharp MZ-80A**, GP Ridley has provided chapters detailing the machine's ROM and RAM, the features of BASIC SA-5510, the various PEEK's and POKE's programming tips with a short feature on converting programs to the Sharp, and ideas on sorting data and data type handling. There is also a comprehensive appendix containing hexadecimal-decimal conversions, the ASCII table and the display code table.

Complete with a goodly selection of actual programs to illustrate the prowess of the Sharp MZ-80A, the book is priced at £4.30 including postage. The book can be obtained from D C Brennan Eng, 14 North Western Avenue, Watford, Herts WD2 6 AE.

WORDS ON THE APPLE

Little Genius have announced a new software package allowing you to play Scrabble on your 48K Apple with discs. The game can either be played by four humans, or the computer can play all four players, or any other combination of players and computer. There is also a black and white option of the game for those of you without a colour television or monitor to play the game on.

There is an extensive dictionary offered by the package so the computer will rarely be lost for words; there are also four levels of difficulty. All scoring is kept automatically on the screen.

Retailing at £24.95, you can find out more about Computerised Scrabble from Little Genius, Suite 504, Albany House, 324 Regent Street, London W1 5AA. Telephone enquiries can be obtained on 01-580 6361.

IT'S ONE FOR THE MONEY

If you're in business and looking to microcomputers to solve all your problems, you'll most likely be turning your eye towards the wealth of commercial financial spreadsheets around on the market.

But that choice can often be a difficult one. Financial spreadsheets can vary in many respects: the number of rows, columns, windows and user commands; the ease of programming; whether it can manage the various displays you require; and finally, is it worth the money?

Well, the Management Information Corporation seem to have done the job for you. In a series called Packaged Software Reports, MIC have evaluated PeachCalc, SuperCalc, VisiCalc, CalcStar and MicroPlane, and these reports are now available for £48.

Further information can be obtained from MIC, 60 Belmont Road, Hastings, East Sussex TN35 5NR or by 'phoning 0424-715921.

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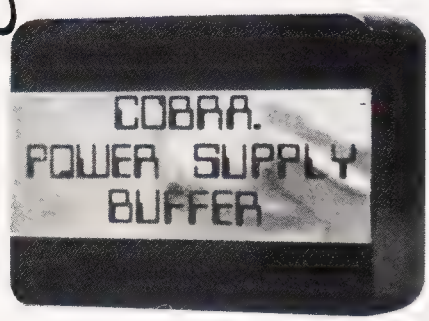

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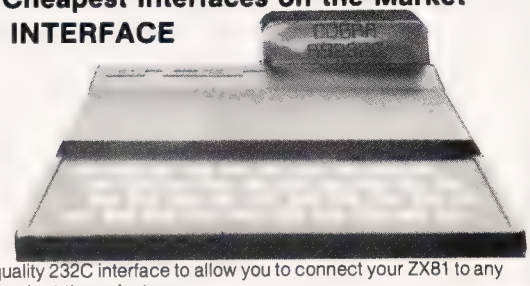

At last a high quality 232C interface to allow you to connect your ZX81 to any 232C printer. Look at these features:
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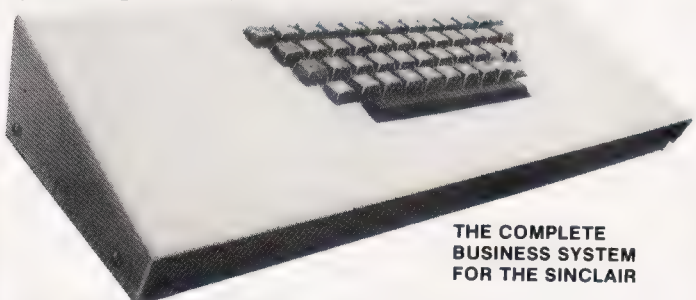

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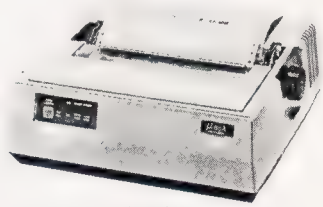

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AN APPEALING COMPUTER?

What does a company do when it already makes one of the most successful computers in the world? Well, it naturally tries to make a better model to fill a new sector of the market. After one false start and considerable problems in the development, that's exactly what Apple have done with their Apple III system. Aimed at the business market, where the Apple II already has a strong foothold, the system should benefit from all the existing software written for the Apple II and, one hopes, be an altogether more professional machine.

In reality...well, that would be giving away the secrets of our review wouldn't it. So, if you are considering a system of that sort of power and price you can't really afford to miss our January issue. Can you?

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PASCAL PROFILE

The advantages of programming computers in different languages is that each language tends to suit one particular area of application; COBOL for business users, FORTRAN for scientific and engineering and BASIC for general purposes. In the past, ***Computing Today*** has brought you series on BASIC, Assembly Languages and FORTH, so it will come as no surprise to learn that we hvae a new one lined up.

This time it's on Pascal, that language that all the academics argue about, stressing its structured nature and how it forces you to write good programs. Certainly it does constrain the user but it often tends to put people off as they regard it as being too difficult to learn. In an effort to get around this, our series has been written by a programmer who has converted from BASIC to Pascal allowing us to show the advantages (and disadvantages) that Pascal posseses. Each of the major Pascal structures is simply explained and all the example programs are written in as 'standard' a version of Pascal as possible to make their use on different systems as easy as possible.

So, if you fancy a challenge and feel like developing your programming skills follow our series for the next few months — we're certain you won't regret it.

THE SECRETS OF PEEK AND POKE

To many people these are just two BASIC commands, well, one's a function actually but who's complaining. To others, they are very useful in programming simple (or even not so simple) games that make use of graphics. Yet still other programmers look at them as the way to break into the world of machine code programs.

As you might have realised by now there is a lot more to these two simple (?) words than first meets the eye and in an effort to break down the last remaining barriers to their understanding, we'll be taking a long hard look at the sort of uses they can be put to.

Articles described here are in an advanced state of preparation but circumstances may dictate changes to the final contents.

Mike James

BBC PROGRAMMING

In our occasional series on the BBC Micro, we take a look at the SOUND command.

Part of the attraction of the BBC Micro is that it has enough features to turn learning its use into a lifetime's occupation! I don't mean this to be taken as a critisism because it really is important for a personal computer to be sufficiently well-designed to be easy to use at first but complicated enough to offer a continuing challenge after the initial novelty has worn off. A lot of fun using the computers comes from exploring unknown territory — hold on a minute, could this be why Acorn were so long in producing the final version of the BBC Micro's manual!!

Anyway, the territory which forms the subject of this short article is so vast that it alone could keep a BBC Micro owner supplied with interesting projects for many months. For, although the BBC Micro has only a single sound generator chip with one noise channel and three tone channels, the software built into the BASIC to handle it makes it more powerful than the hardware specification might lead you to believe. Indeed, it is so powerful and flexible that this article can cover only a fraction of the possiblities!

SOUNDINGS

Before launching into details of how the BBC Micro's sound generator can be used, it is worth taking an overview of the sort of things it can do. There are three tone generators which can be used to produce either single notes or up to three-note chords. There is, in addition, a single noise channel which can produce eight different effects.

This fairly simple hardware is controlled using two extensions to BASIC — SOUND and ENVELOPE. The SOUND command is the only one of the pair which actually causes anything to come out of the tiny speaker just above the keyboard. Among other things, it controls pitch, amplitude and duration of the notes produced. The ENVELOPE command is used to change the characteristics of the notes produced by the SOUND command. Used without the ENVELOPE command, SOUND produces a more or less pure tone with a given frequency, which is fine for most applications — eg beeps during games or playing simple tunes. However, if you want to try to produce more complicated sounds then you have to use the ENVELOPE command to alter the basic sound produced.

There are two general reasons for wanting to produce more complex noises — either you are interested in music and making your BBC Micro sound like a piano, flute, organ, guitar . . . or you want to make especially convincing sound effects such as a police siren, gun shot, etc.

The study of the BBC Micro's sound capabilities, therefore, falls into these two catagories — music and sound effects.

MAKING MUSIC

There are three levels of difficulty involved in making music with the BBC Micro:

1) playing simple tunes,
2) playing music with three-part harmony, and
3) 'synthesising' the sound of of other instruments.

The first two involve the use of the SOUND command only but the last one also requires a mastery of the ENVELOPE command and, sadly, falls outside the scope of this month's article. To get very far with either of the three you also need a reasonable understanding of music, but if you feel a little unsure about this then programming sound is a very enjoyable way to learn.

The subject of sound effects is much more limited because all that we are trying to do is to compile a catalogue of 'recipes' to make a few standard noises. However, there are two ways of approaching sound effects: you can either use the SOUND command to control the noise channel or you can use the ENVELOPE command to define basic sounds. With the latter you can produce quite remarkable effects but there's still a great deal of scope for producing a wide variety of noises using the SOUND command.

The rest of this article will concentrate on the use of the SOUND command and will try to convey some of the flavour of the uses of the BBC Micro's sound generator. (The ENVELOPE command is so complex and versatile that it demands an article to itself!) To get us started a brief resumē of the SOUND command seems appropriate.

SOUND

The SOUND command has the general form:

```
SOUND C,A,P,D
```

where C controls which channel (0, 1, 2 or 3) produces the sound (channel 0 is the noise channel). A controls the volume and ranges from 0 (silence) to − 15 (loudest); P controls the pitch of the note and ranges from 0 (lowest pitch) to 255

(highest) and D controls the duration of the note and ranges from 1 to 255 in twentieths of a second. There are various extra meanings associated with the parameters C and A. Positive values of A in the range of 1 to 4 cause the pitch and volume of the note to be controlled by the parameters of the ENVELOPE command. The channel parameter C is, in fact, quite complicated and is best thought of as a four-digit hexadecimal number:

```
&HSFN
```

where each of the letters stands for a digit which controls a different aspect of sound production. What exactly each of them does is better left until later except to say that N is the channel number as described earlier.

PROGRAMMING TUNES

Programming tunes is simply a matter of converting notes into numbers. This is easy once you know that middle C corresponds to a value of 53 and going up or down by a whole tone corresponds to adding or subtacting 8. The only thing that you have to be careful to remember is that there isn't always a whole tone between two notes. For example, between the notes of C and D there is a whole tone but between E and F there is only a semitone. The pattern of tones and semitones from C to C, an octave above, is:

```
C - D - E - F - G - A - B - C
  T   T   S   T   T   T   S
```

which is easy to remember because it's the same as the pattern of white and black notes on the piano. Obviously sharps and flats can be produced by adding or subtracting 4. So, you can produce the full chromatic scale by:

```
10  FOR P=53 TO 97 STEP 4
20  SOUND 1,-15,P,10
30  NEXT P
```

This short program can also be used to demonstrate a unique feature of the BBC Micro. If you add line 15:

```
15  PRINT P
```

you will discover that the numbers are printed on the screen and the program finishes but the sound keeps on coming. The reason for this remarkable behaviour is that the BBC Micro maintains a queue of sounds which are produced one after the other as soon ab the current sound is completed. The sound queue is processed independently of any BASIC program that is running and each SOUND statement simply adds a note to the end of the queue. This means that a BASIC program isn't held up for the duration of each note. The only time that this fails is when the queue becomes full and a SOUND statement tries to add another note to it. The result is that the program then has to wait until the end of the currently sounding note when the queue is reduced by one and the SOUND statement can add its note.

To make a tune recognisable, not only must each note be at the right pitch, but each note must last for the correct time. The normal system of musical notation is based on repeatedly dividing a time interval by two to obtain shorter notes, so it is a good idea to include a variable in all music programs which sets the length of the fundamental unit of time. As an example of programming a simple tune consider the first few notes of 'Hearts of Oak' (see Fig. 1). Translating each note to its pitch and duration value for the SOUND statement gives the two rows of numbers under the music in Fig 1. The best way to convert these numbers to sound is to use a DATA statement thus:

```
 5  C=5
10  DATA 69,1,89,1,89,0.75,89,0.25,
    89,1,105,0.75,97,0.25,89,1,85,
    0.75,77,0.25,69,0.75,99,99
20  READ P,D
30  IF P=99 THEN STOP
40  SOUND 1,-15,P,D*C
50  SOUND 1,1,P,2
60  GOTO 20
```

Line 50 has the effect of leaving short silences between each of the notes. Without this line, all the notes run together — try deleting it and re-running the program to appreciate the effect, it is one that you'd want to use to 'slur' notes. You can program any tunes that you have music for in much the same way.

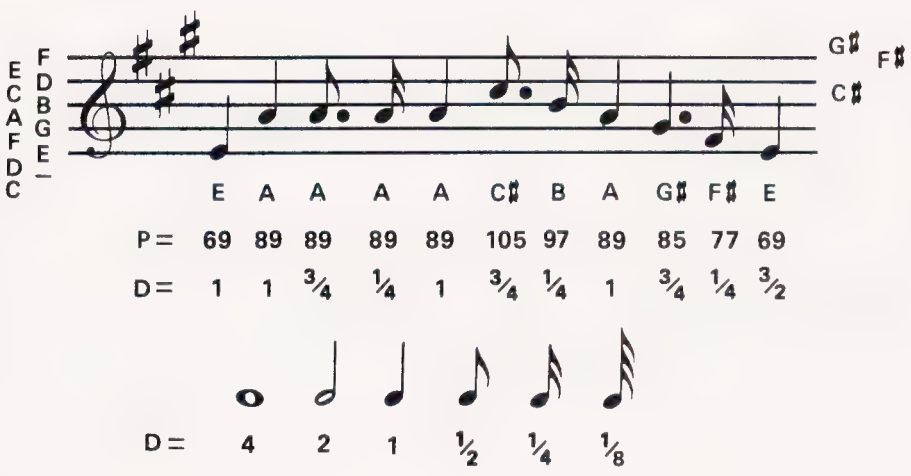
STRIKING A CHORD

Most home computers with a sound generator could manage the simple tune given in the last section. What is special about the BBC Micro is that it is possible to generate three notes at the same time. To see how this sounds, try the following:

```
 10  DIM N(13)
 20  DATA 53,61,69,73,81,89,99,101,
     109,117,121,129,137
 30  FOR I=1 TO 13
 40  READ N(I)
 50  NEXT I
 60  A$=INKEY$(0)
 70  IF A$="" THEN GOTO 60
 80  A=VAL(A$)
 90  SOUND 1,-15,N(A),20
100  SOUND 2,-15,N(A+2),20
110  SOUND 3,-15,N(A+4),20
120  GOTO 60
```

If you RUN this program (by pressing each of the keys 1 to 8) you will be able to hear the eight chords produced by adding a third and a fifth to each of the notes in the scale of C. (A third is a musical interval corresponding to playing a note two notes higher up and a fifth corresponds to playing a note four notes higher up.) This is the simplest kind of chord, called a triad, and is very pleasing to the ear.

Typing in almost any combination of the number keys 1 to 9 will produce something tuneful and it is easy to sit at your BBC Micro and produce 'music'. For example, if you want to hear a snatch of tune which is almost



A • FOLLOWING A NOTE INCREASES D BY 50%

Fig. 1. The first few notes of Hearts of Oak and their digital values for the SOUND command.

recognisable, try typing in the following sequence:

```
5 5 6 6 4 5 7 7 8 7 6 5
```

No prizes for guessing this one! The array N is used to hold the pitch values for the notes of the scale of C and enough notes higher up to form the triad on B. You can write a program to play a piece of music with up to three-note chords using the same method as given for the single melody in the last section.

There is one thing wrong with the previous program, however, and that is that each note of the chord starts at a slightly different time. In other words, each of the SOUND commands starts its note in the chord as soon as it is reached and, as they are executed one after another, the note on Channel 1 starts a little before that on Channel 2 which starts a little before that on Channel 3. The solution to this problem would be to tell the sound generator to wait for two other notes after the one intiated by line 90 before making any noise at all. This is the purpose of the S part of the channel parameter introduced in the section about the form of the SOUND command. If you use a non-zero value for S, the sound generator will wait for other notes before it starts playing. The number of notes that it waits for is given by the value of S and the SOUND commands which produce them must also use the same value of S. For example, in the case of the triads played by the previous program the SOUND commands would be replaced by:

```
 90  SOUND &0201,-15,N(A),20
100  SOUND &0202,-15,N(A+2),20
110  SOUND &0203,-15,N(A+4),20
```

The first SOUND command has a value of S equal to 2 so the sound generator waits for two more SOUND commands with S set to 2 before producing a chord made up of all three notes.

The other parts of the channel parameter are also to do with the timing of notes. The H part of the parameter can either be a 0 or a 1 and if it is a 1, it adds a dummy note to the sound queue which allows any previous notes to continue without being cut short by another note. This really only makes any sense when used with the ENVELOPE command. The F part can be either 0 or 1 and if it is 1, it causes any notes stored in the channel's queue to be removed or 'flushed' and the note specified by the current SOUND command to be produced immediatly.

SIMPLE SOUND EFFECTS

The only sound channel that we haven't discussed as yet is the noise channel — Channel 0. The noise produced by this channel depends on the value of the pitch parameter P in the SOUND command:

P	Noise
0	High frequency periodic
1	Medium frequency periodic
6	Low frequency 'white' noise
3	Periodic of a frequency set by Channel 1
4	High frequency 'white' noise
5	Medium frequency 'white' noise
6	Low frequency 'white' noise
7	Noise of frequency set by Channel 1

The first three noises (P= 0 to 2) are rasping sounds which come in very handy for 'losing' noises in games! Values of P between 4 and 6 produce hissing noises of various frequencies. White noise is a special sort of hissing which is made up by mixing a note of every pitch in much the same way that white light is made up by mixing light of every colour.

There isn't very much that you can do to change the nature of the sounds produced when P has a value of 0, 1, 2, 3, 4, 5 or 6 apart from altering the volume and duration. However, by changing only these two parameters and combining noises, you can still produce a useful range of effects. For example, if you make any noise very short it begins to sound 'percussive' (like something being hit) and if you combine a very short burst of white noise with a very short high pitched tone, you produce a noise like a metalic click. Try:

```
10  SOUND 0,-15,4,1:
    SOUND 1,-15,200,1
```

Similarly, mixing two noise-like sounds produces new effects. The following example:

```
10  SOUND 0,-15,4,1:SOUND 0,-15,3,1
20  GOTO 10
```

produces a sound like a machine gun. Notice that as this example uses the same channel twice, the two sounds follow each other to give a rhythmical pulsing sound. Using this idea with two different pitches of 'white' noise produces a sound like a helicopter:

```
10  SOUND 0,-15,4,2
20  SOUND 0,-15,5,1
30  GOTO 20
```

Notice that one of the sounds has to be twice as long to give the pulsating beat of a helicopter's rotor blades. You can go on experimenting like this for days! The range of sounds which can be produced using Channel 0 alone is so great that discovering new sounds is easy — putting a name to them, however, is quite a different problem!

The pitch values 3 and 7 are special because they produce noises on Channel 0 which are controlled by the pitch on Channel 1. This opens the door to sound effects which involve noises which change in pitch. For example:

```
10  SOUND 0,-15,7,55
20  FOR I=200 TO 255
30  SOUND 1,0,I,1
40  NEXT I
```

produces a noise like a space ship taking off. The pitch of the noise on Channel 0 started by line 10 is continuously changed by line 30. Notice that using a volume of 0 means that the sounds produced by line 30 are silent! Finally, try:

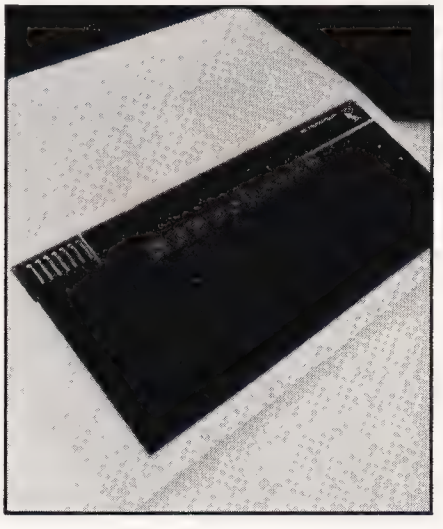
```
10  SOUND 0,-15,7,55
20  SOUND 1,0,200,1
30  SOUND 1,0,255,1
40  GOTO 20
```

which produces a sound like a car engine being started (or rather failing to start!).

DEEPER INTO THE UNKNOWN

Some of the simple sound effects developed here can be considerably improved by use of the ENVELOPE command but for occasional use, it seems like 'overkill' to use anything more than SOUND. However, when it comes to music then the ENVELOPE command has a lot going for it!

In the next part of this occasional series, the lure of the unknown proves too strong and an expedition will set out into the darkest recesses of ENVELOPE!



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CONNECTIONS

Our occasional series on the basics of computer hardware finally comes to a graceful halt considering the simple logic elements.

SCHMITT TRIGGERS

Schmitt triggers are used to smarten up the edges of a sloppy pulse. In other words, waveforms fed in are converted to straight-sided pulses at the output. Wherever a signal has not come from the output of a TTL device, it is wise to send it through a Schmitt trigger first before allowing it to enter another TTL device.

For those desirous of brushing up on basic logic gates/flip-flops, etc, the following sparse treatment should be sufficient, see Fig. 33.

Using verbal definitions:

AND gates have output HIGH only if ***all*** inputs are HIGH.
OR gates have output HIGH if ***any*** one or more inputs are HIGH.
NOR gates have output HIGH if ***all*** inputs are LOW.
NAND gates have output LOW if ***all*** inputs are HIGH.
Inverters change LOW to HIGH or HIGH to LOW.

Although the truth tables shown assume two-input gates, the implied definitions still hold for any number of inputs. However, take care, because in TTL any inputs left floating behave as if they were HIGH.

NAME	SYMBOL	BOOLEAN	TRUTH TABLE
AND		AB = S	A B S 0 0 0 0 1 0 1 0 0 1 1 1
OR		A + B = S	0 0 0 0 1 1 1 0 1 1 1 1
NAND		$\overline{AB}$ = S	0 0 1 0 1 1 1 0 1 1 1 0
NOR		$\overline{A + B}$ = S	0 0 1 0 1 0 1 0 0 1 1 0
EXCLUSIVE OR		$A\overline{B} + \overline{A}B$ = S	0 0 0 0 1 1 1 0 1 1 1 0
INVERTER		$\overline{A}$ = S	0 1 1 0

Fig. 33. A brief resume of the logic gates.

NAND GATE DOMINANCE

Bearing in mind the theoretical availability of the complete set of gates, it is mystifying to many people why the average TTL logic diagram is dominated by the NAND gate almost exclusively. The AND, OR and NOR are comparitive rarities. There are two reasons for this. The first is simply because the internal circuitry of the entire TTL system is based on the NAND gate. The second reason is an indirect consequence of the first. The output current available at the gate is 10 times higher when in the LOW state than when HIGH. This is why terminals on counters, shift registers, etc, are generally energised ('activated') by a LOW input. This means that an AND gate with all inputs HIGH, and therefore delivering a HIGH out, would have to have an extra inverter on the output before it could energise the device. But an inverted output AND is, by definition, a 'NAND'.

Figure 34 shows how NAND gates and the odd inverter thrown in can simulate any gating function.

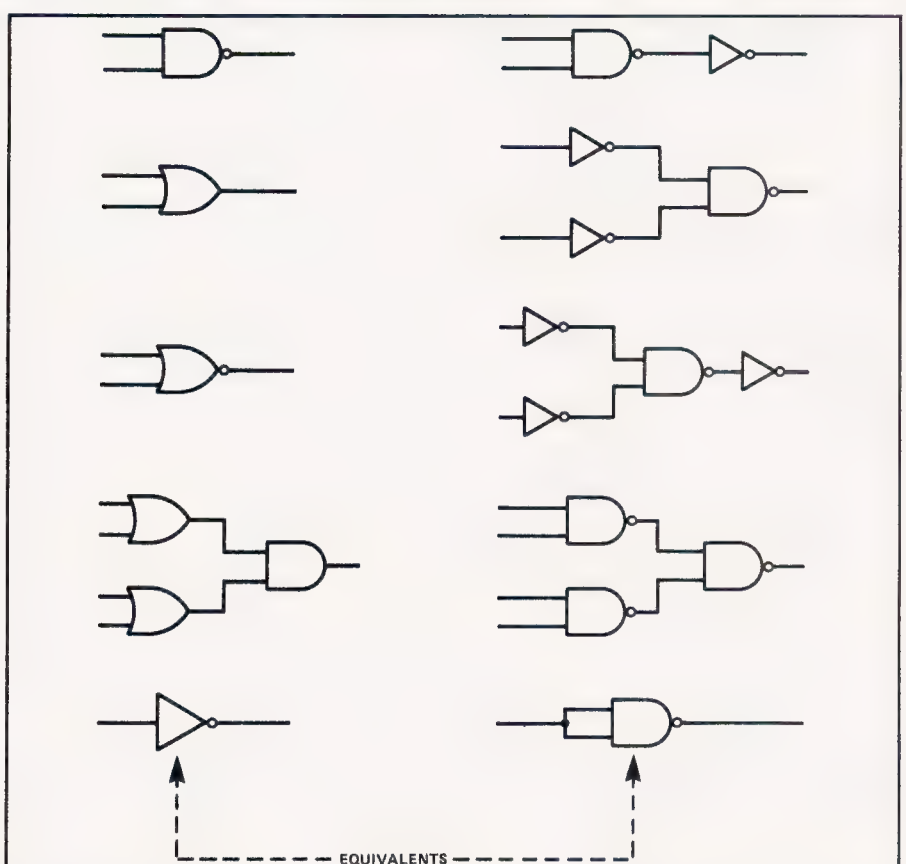

Fig. 34. Simulating AND, OR, NOR and INVERTER logic with NAND gates.

MECHANICAL SWITCHES

Ordinary toggle switches can be used to provide manual HIGH or LOW logic, but there are one or two pitfalls. A simple switch in series is useless in TTL because inputs always float HIGH and would abort the switch action. Figure 35 shows the correct way to use the switch.

If a mechanical switch is to feed a counter or shift register, it is necessary to swamp out the effect of switch bounce (which could push two or three pulses into the counter per single switch throw).

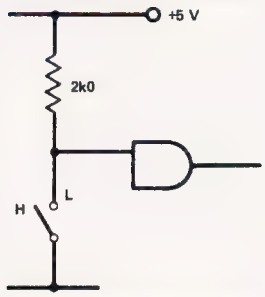

Fig. 35. Switch feeding.

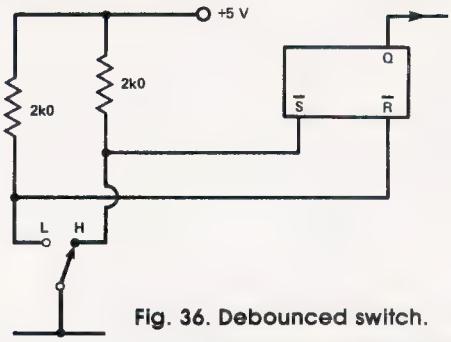

Fig. 36. Debounced switch.

This can be avoided by using the flip-flop as shown in Fig. 36. The flip-flop can be made out of two cross strapped NAND gates (refer to Fig. 22 in the August '82 instalment of this series).

FLIP FLOPS

The output of logic gates reflects the input states as they exist now. The output of flip-flops reflects the input states which existed in the past.

Gates are grouped together under the heading of combinational logic because the output reflects the existing combination at the input terminals. A system existing entirely of gates can be defined explicitly by simple Boolean expressions.

Flip-flops on the other hand introduce sequential logic because the output at any time depends on the sequence of preceding events. As a further distinguishing feature, we could say that flip-flops exhibit a primitive form of memory. . .they can store a '1' or a '0'. Gates have no memory.

Four varieties of flip-flops are recognised:

The simple SR flip-flop. A flip-flop is said to be in the SET state if Q is HIGH ($\overline{Q}$ is LOW). Conversely, it is said to be in RESET state if Q is LOW ($\overline{Q}$ is HIGH).

A momentary LOW on the $\overline{S}$ input causes the flip-flop to assume (or remain in) the SET state. To ensure the RESET state, a momentary LOW on $\overline{R}$ is sufficient. The key word here is 'momentary'. . .no need to maintain it!

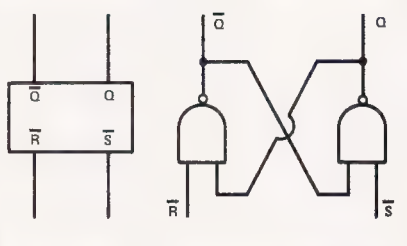

Fig. 37. The simple SR flip-flop.

The 'T' type or Toggle flip-flop: A pulse on the toggle input (T) will change the state. Any subsequent pulse will change it back again, and so on. Usually it is the falling edge of the T pulse which activates the changeover. If so, the rising edge is ignored. If direct set or reset lines are supplied, they take precedence over the T line.

Because of the edge triggering behaviour, the circuit has an inherent divide-by-two function on the input frequency. Thus, if a pulse waveform of 1000 Hz is fed on the T input, the Q output will have a 500 Hz wave (the $\overline{Q}$ output will of course have the same wave but upside down). The waveforms of Fig. 39 may explain this.

The 'T' type flip-flop is rarely found on its own as its functions can be simulated by using an edge triggered D-type (see next page) with the $\overline{Q}$ output linked back to the D input. Alternatively, of course, you can use a JK flip-flop (again see next page) with both the J and K inputs strapped to logic '1'. The input can now be fed to the T input an the device will act as a 'T' type.

Although 'T' types are seldom found on their own, simply because they only have one use, they are the basic ingredient of ripple counters and dividers where their 'divide by two' function enables them to be cascaded and thus provide a 'divide by n' circuit. For more detail on this see the last instalment of Connections in October's **Computing Today.**

THE GREAT DIVIDE

It is often required to 'divide' a frequency by a certain fixed ratio. For example, if the clock frequency available is 1 MHz, a 'divide by two' stage would produce a 500 kHz signal accurately **synchronised** to the input signal.

Providing the division ratio required is a 'digital' number (2,4,8,16, 32, etc) normal binary counters can be used without

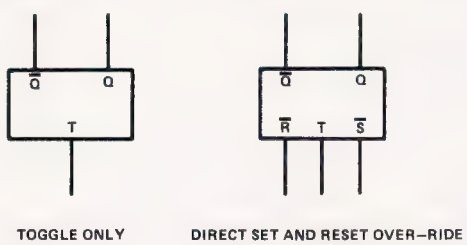

Fig. 38. The toggle flip-flop.

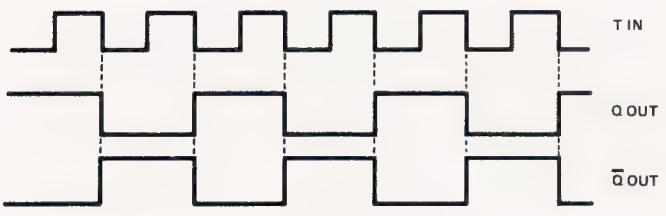

Fig. 39. Input and output wave of toggle flip-flop.

The D-type flip-flop: The 'D' input is not a trigger. It is where the data bit is applied and will enter the flip-flop only when a pulse is applied on the T line. Thus, if a '1' is waiting on a D, the next pulse on a T will latch this '1' on to the Q output. Conversely, if there is a '0' waiting on D, the next T pulse will latch a '0' on the Q output. It is usually the rising edge of the pulse on T which performs the latch action. The 7475 is an example of a Quad D-type Latch which contains four D-type flip-flops arranged in two pairs, each pair having its own T pulse input. There are several variants in the TTL catalogues.

The JK flip-flop: The JK flip-flop is sophisticated. This inevitably means it is difficult to understand! It is designed to cater for all tastes in that any of previously described flip-flops can be 'made' out of a JK. The letters JK by the way have no hidden meaning and were quite arbitrary choices made way back in history.

The two terminals J and K are not trigger terminals. The logic applied to them decide the ***future*** behaviour of the flip-flop when the pulse on T is applied. The behaviour is best described by the table below.

J	K	State of Q after next pulse
		on T
0	0	NO CHANGE
0	1	RESET (Q=0)
1	0	SET (Q=1)
1	1	CHANGE

Notice that if both J and K are held permanently at '1' (HIGH), the behaviour is that of a toggle flip-flop.

If the K terminal is fed via an inverter from the J terminal, the behaviour is that of a D-type, and the J terminal becomes the 'D'. Note that with both J and K at '0', the flip-flop is paralysed, ie T is non-effective.

The label RESET is sometimes written as CLEAR and the T terminal is often referred to as the CLOCK input.

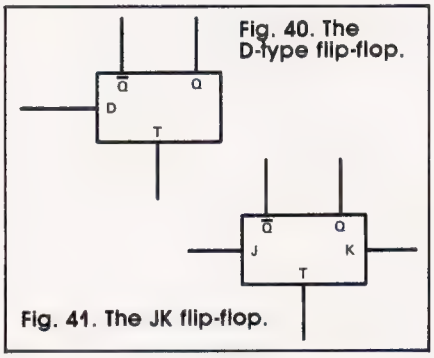

Fig. 40. The D-type flip-flop.

Fig. 41. The JK flip-flop.

DECODERS MULTIPLEXERS AND DEMULTIPLEXERS

First some definitions.

Decoders have many outputs but only **one** can be uniquely selected.
Multiplexers have many data input lines but only ***one*** can be steered to the single output line.
Demultiplexers have many output data lines but only ***one*** can be fed by the single output line.

Decoders can normally function as demultiplexers as well so the terms are often used indiscriminately. Multiplexers are often called 'data selectors'.

Figure 42 illustrates a 16 way decoder which can also function as a demultiplexer. The outputs are active LOW (which is indicated normally by the little bubbles at the output line). Thus, the selected output when used as a decoder would be the ***only*** one in the LOW state. To operate as a decoder, the two enable lines E1 and E2 must be permanently grounded. With the pattern 0000 on the SELECT inputs, only output '0' is driven LOW; with 1111 on the SELECT inputs, only output '15' is driven LOW.

When used as a demultiplexer, one of the enable lines must be held LOW and the DATA IN applied to the other. This data is now 'steered' to the selected output.

Figure 43 shows the 74153 dual 4-way multiplexer which is equivalent to a double pole four-way switch. The enable lines are separate for each section and require a LOW to activate. The pattern on the SELECT lines will 'move' both switch arms as appropriate.

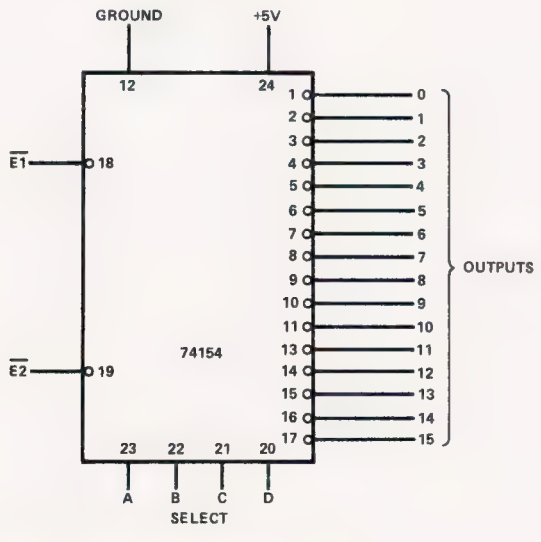

Fig. 42. The 74154 sixteen-way decoder/demultiplexer.

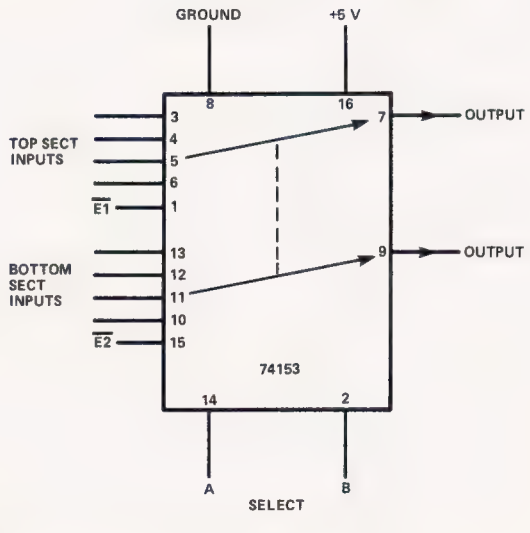

Fig. 43. The 74153 dual four-way multiplexer.

TRISTATE LOGIC

Due to the encroachment of the microprocessor, a need arose for a special kind of output circuit suitable for hooking onto the common bus architecture employed. Standard TTL outputs are useless because it is a serious crime to connect the outputs of two different gates or flip-flops to a common point. The original way out was to use special gates having 'open collector' outputs which allowed gate outputs to be shorted together provided an external pull-up resistor to the + 5V line was connected. This was known as the wired-OR configuration and was at best a sloppy compromise as a general solution to the common bus problem. A black box with 'tristate' outputs is now the classic solution. The extra 'tristate' facility is obtained by connecting an extra transistor switch in series with the output as shown in Fig. 44.

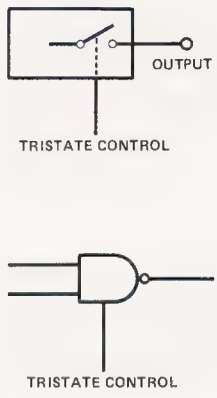

Fig. 44. The idea and the symbolism of tristate control.

The pin labels of the tristate control vary, TE (tristate enable) being perhaps the most popular. Most semiconductor memory chips have tristate outputs on the data lines, the control in this case may often be labelled CS (meaning 'chip select'). In this way, many memory chips can be hung on the same data bus provided that the addressing system only allows one tristate control to be in the on condition at once.

Many of the existing chips in the TTL and CMOS series are now provided with tristate outputs.

SCHOTTKY vs TRADITIONAL.

Traditional or standard TTL uses a 5V supply rail and consumes about 10 milliwatts per gate. The inherant delay through each gate is about 10 nanoseconds (10^{-8} seconds).

Low power Schottky TTL still uses a 5V rail and has logic functions identical to the equivalent standard TTL. However, it only consumes two milliwatts per gate and the inherent delay is only five nanoseconds. Thus, it is twice as fast and consumes only one fifth of the power as standard TTL. Obviously, it is rapidly taking over the market.

The coding for low power Schottky chips is the same as standard except the letters 'LS' are squeezed in between the '74' and the remaining digits. For example: 7400 is a standard TTL chip and 74LS00 would be the equivalent Schottky version. The two types of logic are virtually interchangeable and can be mixed except that LS types have a lower fan out if loaded by standard TTL.

This is a completely different rival rival system using 'Complementary Metal Oxide Semiconductor' technology (CMOS). It uses zero power in the quiescent state (in the nanowatt region) and consequently is the logic of choice where low power dissipation is the major performance criterion. It is slower than standard TTL but fast enough for current microcomputer systems. It is said to be easily damaged by static charges when handling and elaborate rituals are laid down to avoid static build up on delicate establishment fingers! Type numbers are unrelated to TTL, the most common being the '4000 Series'.

Unlike TTL, CMOS is quite happy on any supply voltage within the range + 3V to + 15V although if the two systems are to be mixed with a common supply, they must both run on + 5V.

IN CONCLUSION

Finally, before I conclude my series, I would like to leave you with six pieces of advice:

1. Before getting the soldering iron out to implement a complex logic system, search all the catalogues you can get hold of. You may find one or two chips have already been designed to do the job much more efficiently and reliably than a mass of separate flip-flops and gates.
2. Test the external system (you have designed) separately before daring to connect it to the computer. If something smokes or displays other signs of discomfort, the only damage will be to your contraption . . . better than the expensive computer!
3. Never connect the raw outputs of the I/O chip to your circuit. Interpose a couple of inverters between any I/O pin and your pin. Two inverters perform no logic but act as a protective buffer between the interface.
4. Always switch off the computer and contraption ***before*** making the interface connections.
5. Unless you are ***certain*** the computer power supply has surplus amps to spare, resist the temptation to pinch even a few milliamps. You are safer using an independant power supply, but remember that some form of common earth may be required.
6. Make sure you have allowed for a fail-safe state on power-up condition. If, for example, you intend to fire an 'explosive device' under computer control, make sure that it doesn't go off immediately you switch on. There is not much difference between a '1' and a '0' on paper, but is of far-reaching importance when the wrong bit slips into a JK flip-flop!

And that, as they say, is the end of that. I trust that you have found the five sections of this series both informative and useful and perhaps the knowledge you have gleaned has enabled you to solve that little interfacing problem. If it has then it has all been worth it!

INNOVATIVE
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QUICKPRO PLUS

Quickpro Plus is a Basic program generator. That is to say you tell it the type of program you want and it writes it for you. The most widely publicised of such program generators is The Last One and it is, therefore, inevitable that Quickpro Plus will be compared with it.

There are two approaches that one can take in writing software like this. Either one can set out with a very broad brush and try and make the generator capable of producing a wide variety of data handling software or one can restrict it to some extent, to simply producing file handling programs. The Last One seeks to go the first route, Quickpro Plus goes the second. There is a great paradox in this software if one thinks about it. Obviously, if a person is at least a semi-skilled programmer then he does not need a program generator. They are really for people who are not skilled in programming and want that chore taken off their hands. The paradox is that programs like The Last One, by being all things to all men are also complex in use and one therefore gets the position of a program aimed at a beginner, but actually requiring some skill to use it.

It was because of this apparent paradox that Quickpro Plus came into being. It is written for somebody with little or no knowledge. You will find no mention of flow-charts and little mention of fields, records and other technicalities. It was written so that a person could sit down in front of his computer, answer a few questions and have a program produced for him, and this is exactly what Quickpro Plus does. The other side of the coin is that it concentrates entirely on producing file handling programs. Within that context the program which you have generated will run on the computer like any other Basic program. You will be able to add file records, in other words items of information in your file. You will be able to search for and locate records, and retrieve these records, as and when you wish; you will be able to up-date and change the records, indeed you can delete them altogether. In the program generation process you will be able to design your own screen layout. Co-ordinates appear on the screen and you simply say where you want questions and statements to be inserted. You will, of course, be able to define whatever part of the record you will wish to use as a search key. These fields may be restricted if you wish to just numeric data and, of course, you may name the data file and indeed the program as you desire.

A unique and very useful feature of Quickpro Plus, that we have not seen on other programs, is its ability to automatically print an Instruction Manual for the program which the user generates. This includes the screen layout. Its length, of course, depends on the complexity of the program, but it does seem to contain all of the instructions which a user would need in order to run a generated program.

Yet another feature is that you may carry out various calculations on any of the numeric fields and if you want to you can change this numeric data. Up to fifty separate computations can be carried out on these fields. The program will report the calculations to you in various arrangements using any of the normal mathematical functions.

Quickpro Plus supports a full print report facility. Indeed within minutes you can design a new report with any column names that you choose, with any calculations that you might want and for many selections of records in your total file. A report will be produced within seconds. This can have been built into the program or you can re-arrange matters so that you get a one time reporting. The same file is thereby manipulated in many different ways. Computations are done and results printed all from the same file which your program has produced.

Quickpro Plus is available for the Model I, Model II and Model III Tandy machines, together with the original Video Genie, the Genie I and Genie II. A version for the Genie III will be available towards the end of 1982. Quickpro Plus is, of course, disk orientated and has no application for cassette users. It is supplied on a protected disk, but Molimerx have masters from which they can repair any damaged disks and hence retain their reputation for support.

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Penetrator

Penetrator is a superb arcade type space game with excellent graphics, challenging situations, training options — and much more! You will have to cope with radar attack, missiles, enemy paratroopers and other dangers.

You are in a single fighter plane as the sole survivor of a space fighter squadron, whose mission it is to invade enemy defences and to destroy their neutron bomb cache. The mission is highly dangerous and the enemy has installed extremely efficient defences around their neutron bomb stores. These are made up of four defence rings, each with its own special dangers. To get to the neutron bomb store you must penetrate all four. As you knock out defences you are awarded points; 10 for ground missiles, 100 for radar bases, 200 for defending paratroopers and 1000 for the first neutron bomb store. The game supports two players if required.

The game may be customised; a terrain editor is included in the package and in this way, the landscape, number and positions of the missiles and radar bases can be changed by the user. Excellent graphics and, of course, sound. Compatible with all Genies and the Model I and Model III TRS-80.

PENETRATOR (Tape) ... ... **£ 9.95**
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STRIKE FORCE

A fast moving arcade type space game. Full of action and plenty of surprises!

In some ways this is a similar game to Penetrator. We think it is slightly better, but tastes vary. The chief difference is that a "preview" of approaching enemy forces is shown at the top of the screen, rather in the same way as our Defend game. The aim of the game is to penetrate defences to obtain access to a neutron bomb. In order to do this you have to collect some incendiary star shells. This is done by way of a rather tricky manoeuvre, whereby one has to manoeuvre one's ship to sit on the star shell, rather like a hen hatching an egg. When the position is just right the star shell attaches itself to your ship.

To play Strike Force you will need skill, cunning, fast responses and a keen sense of strategy. Most people find it more taxing than Penetrator and the "preview" of advancing forces is certainly one of the key features of the game. It does, of course, have sound. Both Strike Force and Penetrator are published by Melbourne House, an Australian Company. Strike Force is compatible with all Genies and the Model I and Model III TRS-80.

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ZX CONNECT

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The program, which occupies about 2K of memory, uses the screen display to remember the current position. Although the program plays a reasonably strong game, there are ways of improving on it which are suggested later.

The main subroutines are at the beginning of the program to reduce running time and the maximum time for the computer to make its move is about 14 seconds. The main program from line 320 defines the variables necessary, before printing the playing area and memory mapping it with the PEEKs familiar to most ZX80 users. If the program is to go first, it chooses its column at random using the subroutine from line 20 to find the lowest square. The human's column number is then INPUT and the same subroutine finds the lowest square and returns to line 610 where the human's move is POKEd into the playing area. The subroutine from line 110 is then used to check if the human has won. This subroutine also evaluates the weightings given to each possible move for the program; it then selects the best by the sort routine in lines 660 and 670.

If at any move either the human or the program obtains four in a row, the program diverts to the final routine which prints the winning row in inverse video, cancels the move instruction and gives the result.

WEIGHTING IT

The weightings given for various row possibilities are contained in line 240 and are the first values the author thought of when writing the program! Surprisingly, they make the computer a reasonably strong player but they could probably be improved by making them variables and writing a main program which caused the Connector program, as a subroutine, to play itself with different values for these variables.

A way of making the program an extremely strong player, however, would be to give it a look-ahead facility by checking the human's options before he or she got the chance to move. This could be done in a simple way by running the subroutine from line 20 again but returning to re-evaluate the program's best move in the light of the look-ahead. Probably a one—ply look-ahead would be adequate to make the program virtually unbeatable.

As the program stands, however, it will give the average four-in-a-row player a good game, but a challenge, which may prove harder than winning, would be to force the program into a draw.

Program Listing

```
 10  GOTO 320
 20  LET A=PEEK(16396)+256*PEEK(16397)
 30  LET N=A+B+11
 40  IF NOT PEEK(N)=0 AND C=0 AND B=7 THEN GOTO 880
 50  IF NOT PEEK(N)=0 THEN NEXT B
 60  IF PEEK(N+10)=0 THEN GOTO 80
 70  GOTO 100
 80  LET N=N+10
 90  GOTO 60
100  IF P=1 THEN RETURN
110  LET P=0
120  LET W=0
130  FOR F=0 TO 3
140  LET T=F=0 AND 1 OR F>0 AND 8+F
150  FOR G=0 TO 3
160  LET E=0
170  FOR H=0 TO 3
180  LET D=PEEK(N+T*(H-G))
190  IF D=9 THEN NEXT G
200  LET E=D=52 AND E+1 OR D=61 AND E-1 OR D=0 AND E
210  NEXT H
220  IF E=3 THEN GOTO 730
230  IF E=-4 THEN GOTO 820
240  LET W=W-1000*(E=-3)-50*(E=-2)-10*(E=-1)-(E=0)-
     20*(E=1)-40*(E=2)
250  NEXT G
260  NEXT F
270  RETURN
280  FOR X=0 TO 28
290  POKE A+X+95,3
300  NEXT X
310  RETURN
320  PRINT "ZX80 CONNECTOR"
330  PRINT "SHALL I GO FIRST? Y/N"
340  INPUT B$
350  CLS
360  LET A=22222
370  LET B=4
380  LET C=0
390  LET D=0
400  LET E=0
410  LET F=0
420  LET G=0
430  LET H=0
440  LET N=0
450  LET P=0
460  LET T=1
470  LET W=0
480  LET X=0
490  PRINT "[9^A]"
500  FOR M=0 TO 5
510  PRINT "[^A][7 SPC][^A]"
520  NEXT M
530  PRINT "[9^A]"
540  PRINT " 1234567 "
550  PRINT "YOUR MOVE GIVE COLUMN NUMBER"
560  IF B$="Y" THEN GOTO 690
570  LET P=1
580  INPUT B
590  IF B<1 OR B>7 THEN GOTO 580
600  GOSUB 20
610  POKE N,61
620  GOSUB 110
630  LET C=0
640  FOR B=1 TO 7
650  GOSUB 20
660  IF W>C THEN LET M=N
670  IF W>C THEN LET C=W
680  NEXT B
690  LET A=PEEK(16396)+PEEK(16397)*256
700  IF C=0 THEN LET M=A+61+RND(7)
710  POKE M,52
720  GOTO 570
730  FOR H=0 TO 3
740  POKE N+T*(H-G),180
750  NEXT H
760  GOSUB 280
770  PRINT "I WIN"
780  PRINT "ANOTHER GAME? Y/N"
790  INPUT B$
800  IF NOT B$="N" THEN RUN
810  STOP
820  FOR H=0 TO 3
830  POKE N+T*(H-G),189
840  NEXT H
850  GOSUB 280
860  PRINT "YOU WIN"
870  GOTO 780
880  GOSUB 280
890  PRINT "DRAW"
900  GOTO 780
```

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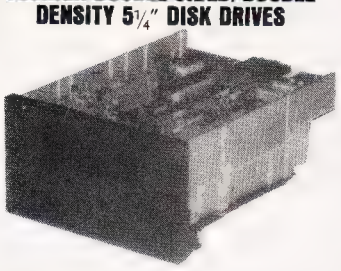

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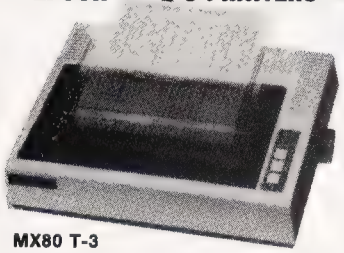

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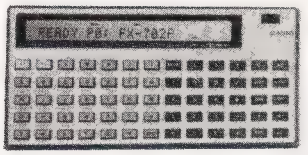

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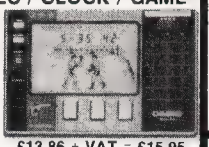

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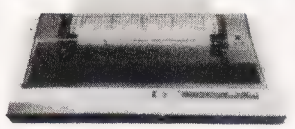

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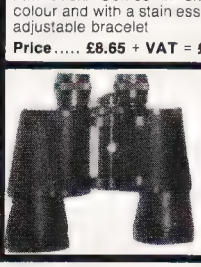

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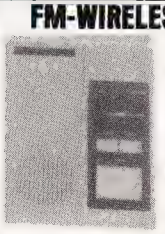

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ASP SOFTWARE

Paul Kriwaczek

MICRO MUSIC

In the second part of this article, we look at a miraculous music generator called MICRAULOS.

While music software systems are not yet fully perfected, many manufacturers have opted for the hardware approach, using dedicated music chips. These consist in the main of a number of programmable counters (often three of them) one for each channel or voice, which can generate a square wave output ranging from about 50 to roughly 8000 Hz, the limits of most musical sounds. Another channel is usually provided, a random noise generator, useful for explosive or percussive unpitched sounds. The output of these circuits usually then goes to the same number of amplitude controllers, which may be programmed either directly by the user or by a programmable automatic envelope generator included on the chip. Often other functions such as extra input/outputs and facilities for reading the contents of the registers are included, but they need not concern us here.

One of the most popular of these music chips in use at present is the General Instruments AY-3-8910; its internal construction is as shown in Fig. 8. Driving music chips like these is fairly simple, particularly if they are connected to the micro via a PIO (programmable input/output) or VIA (versatile interface adaptor); a suitable circuit is shown in Fig. 9. There are two chip-select pins – A8 and A9. Each function on the chip is controlled by one or two registers, so all that is necessary is to load them with data. The only complication is that on some microprocessors, to save pins on the package, the address and data lines are multiplexed; that is, they are combined into the same pins – DA0 to DA7. Three inputs to the chip: BC1, BC2 and BDIR, are used to tell the sound generator whether to regard the inputs as data or address. So the routine goes something like:

1) Set BC1, BC2, BDIR to prepare the bus to receive a register number.
2) Set DA0-DA7 to the register number.
3) Set BC1, BC2, BDIR to prepare the bus to input data.
4) Set DA0-DA7 to the data to be entered to the chosen register.

As no handshaking is necessary, this can even be done without difficulty by POKEing the relevant port or output addresses from BASIC.

Very often, music programs for microcomputers consist of no more than the chip driver routine. The bytes to be sent to the chip are stored as data statements and a READ instruction picks them up one by one and POKEs them to the output adddress. This is not really a satisfactory way to do the job.

SQUARE MUSIC

To begin with, the automatic envelope generator in the chip is a rather crude device allowing for few of the refinements mentioned last month, and is certainly unable to create the kind of effect shown in Fig. 3. And then, there is the sound itself, composed entirely of square waves. The square wave is a sound made up of a fundamental frequency and a diminishing series of odd harmonics; thit is: f, f ★3, f ★5, f ★7, etc. There is a characteristic hollowness of sound to this kind of wave shape. In a synthesisier, it is useful as a basis for recreating such instruments as clarinet and some organ pipes, but it is not very exciting to listen to unmodified. It is quite possible to pass the output of the chip through

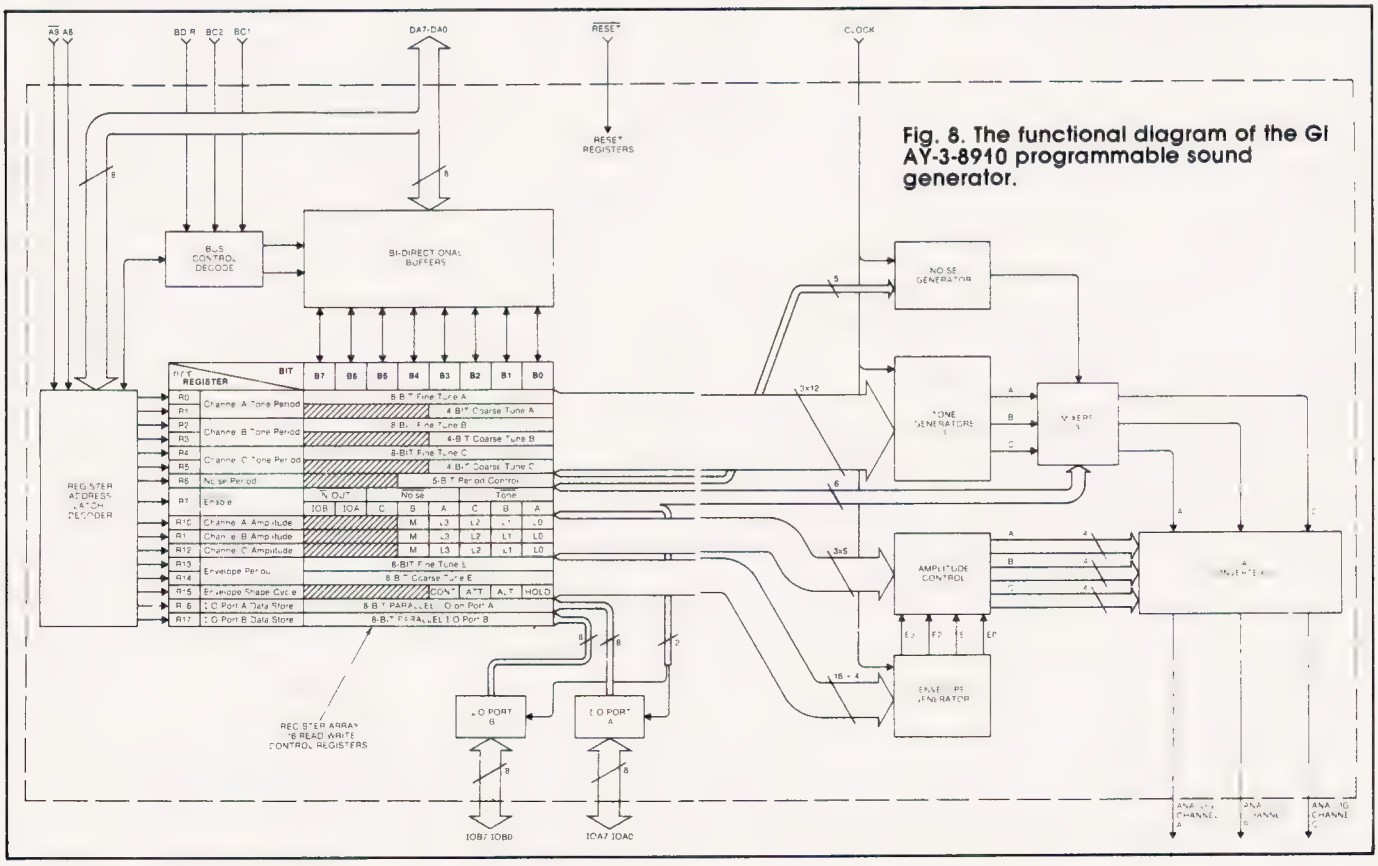


Fig. 8. The functional diagram of the GI AY-3-8910 programmable sound generator.

an adjustable filter, which will effectively change the amplitude relationship between the different harmonics. But we are still left with odd harmonics only, unless we change the actual shape of the wave.

However, modifying the shape of the wave emenating from a sound generator chip is not an easy process. The normal procedure would be to pass the output through some kind of 'waveshaper', essentially a non-linear amplifier. But this has to be done before the envelope is applied, otherwise the effect on waves of high and low amplitude would be quite different.

It is possible, however, to alter the square waves in a different way – by full wave rectification. As we can see in Fig. 10, if rectifiers were perfect, there would be no change in the overall shape of the wave – but they aren't; and in any case, we can make sure of it by limiting the frequency response. Having rectified the wave, we have effectively multiplied the fundamental frequency by two, thus supplying many of the even harmonics which were missing from the original. If we now pass the result through a low pass, high pass or band pass filter, we begin to approach standard synthesiser technique. The filter could even be a programmable device, perhaps controlled by means of the spare I/O ports on the sound chip.

And rectification can present us with even further possibilities. By very heavily low pass filtering the rectified output, we have an 'envelope follower' and can use its signal to over-ride the tuning of the tone filter. Of course all this circuitry adds up to something rather more complex than a computer CPU board, but for serious sound production, the extra chips are probably worth the effort. Some suitable circuits are shown in Fig. 11.

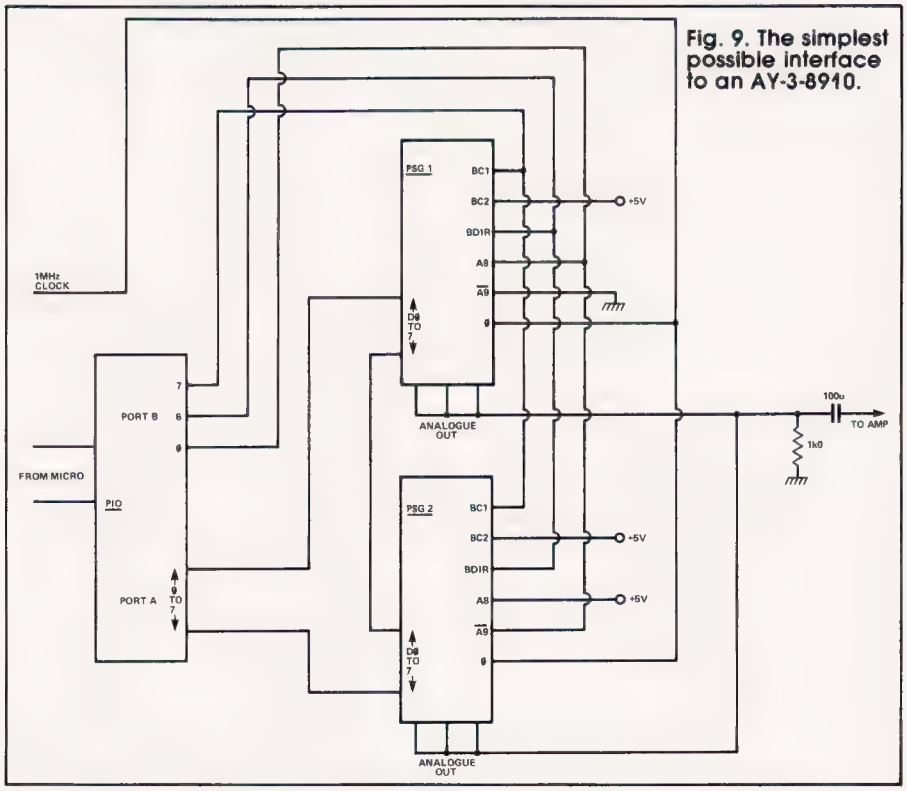


Fig. 9. The simplest possible interface to an AY-3-8910.

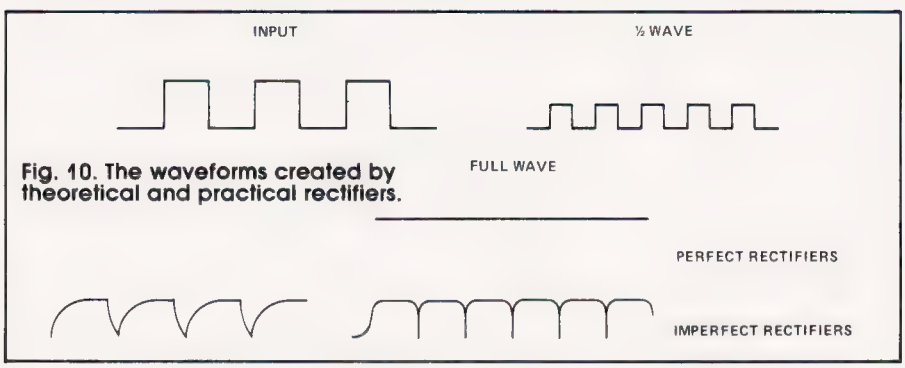


Fig. 10. The waveforms created by theoretical and practical rectifiers.

SOUNDS GOOD

That takes care of the static characteristics of the sound, but great improvements can be made over the envelope generator on the chip. Since the amplitude control of each voice can be programmed from the host computer, full control of the envelope is possible by writing a new volume level for the voice every few milliseconds; the instantaneous pitch can also be adjusted at the same time.

When a note is sent to the sound chip, the play routine picks up its volume from an envelope table. As long as the note is

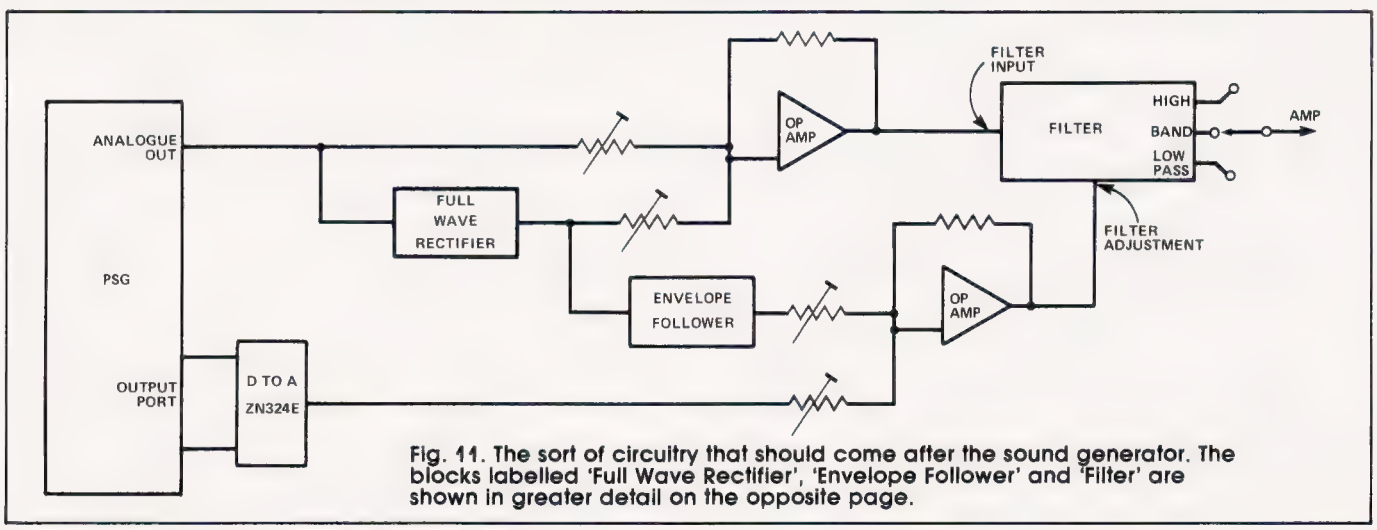
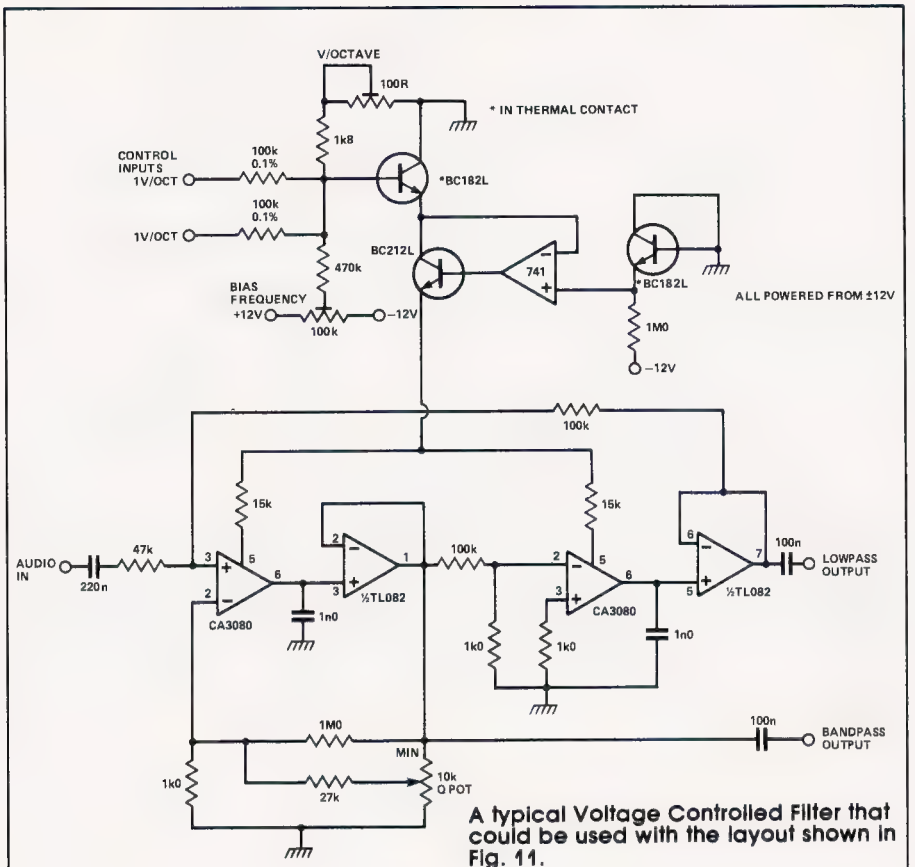
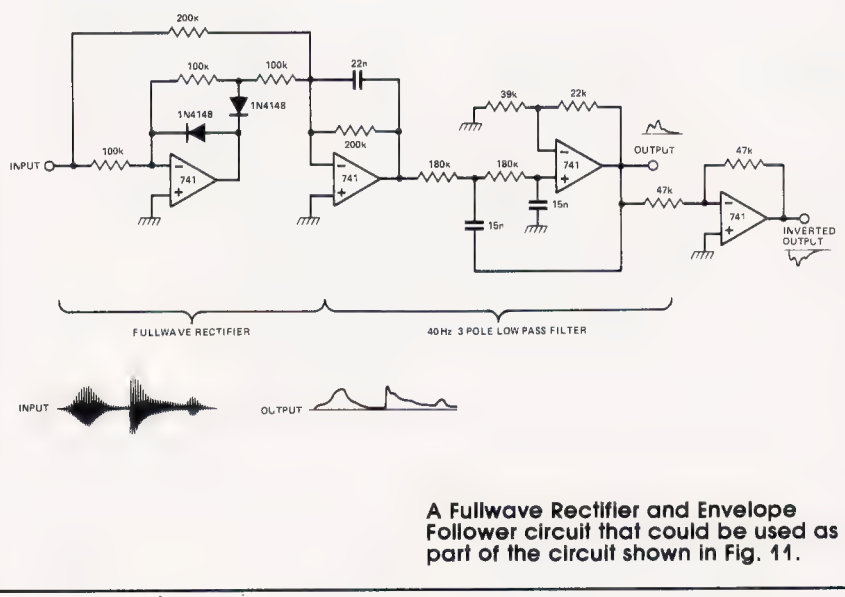


Fig. 11. The sort of circuitry that should come after the sound generator. The blocks labelled 'Full Wave Rectifier', 'Envelope Follower' and 'Filter' are shown in greater detail on the opposite page.



A typical Voltage Controlled Filter that could be used with the layout shown in Fig. 11.



A Fullwave Rectifier and Envelope Follower circuit that could be used as part of the circuit shown in Fig. 11.

sounding, the volume is repeatedly updated from the table. Similarly, a variable pitch offset can be applied whenever the chip's registers are updated. Between them the volume adjustment and pitch offset can be used to generate a pitch and volume envelope approaching the sound of a real instrument and far greater control is exercised than if only the on-chip facilities are used.

But the 'play' routine is only half the story, as it must operate on data which has been entered in some way, and preferably in a manner which bears a relationship with customary musical convention. What is needed, in fact, is a 'compiler', which takes in music in a suitable form of musical notation and performs the necessary conversions to prepare the data for playing. Time signatures and key signatures ought to be handled automatically, so that having told the computer that I am entering a piece of music in the key of G, for example, every time I enter the note F, unless marked as a 'natural' it is converted to F#.

The compiler may be written in BASIC or any other high level language, as speed is not an issue in the compilation of the music code. It is best composed of a number of modules, each of which performs a specific task which can be called on when necessary.

MY MUSIC

At this point, it would perhaps be best to examine the details of a particular implementation which I have called MICRAULOS for use on the NASCOM.

The system comprises a compiler, which constructs data tables in memory, which can, of course, be stored on tape or disc, and from which the run-time routine reconstructs suitable bytes to feed the two music chips.

The chips are General Instruments AY-3-8910 programmable sound generators (PSG), which are register oriented and memory mapped, written to through the Z80 PIO.

The registers used by the music system are:

0/1:	Channel A frequency (12 bits)
2/3:	Channel B frequency (12 bits)
4/5:	Channel C frequency (12 bits)
7:	Enable channel A, B and C (eight bits)
8:	Channel A volume
9:	Channel B volume
10:	Channel C volume

Other registers which generate envelopes automatically and control additional eight-bit ports on the chips are unused in this system.

The music data is stored in the Tune Table, which consists of six n-by-four byte arrays. These arrays are empty to begin with and grow as music is entered, so that the software has to keep track of where each voice's data begins. The six voices are arranged sequentially with pointers to the start and end of each one stored in a table just below the arrays. Each voice stores notes as a sequence of four bytes:

Instrument Code – the start address of the instrument table used in implementing the note;
Duration Count and Syncopation Count – the former being the low four bits (max duration 16) and the latter not being used during runtime but only by the compiler;
Pitch – which actually uses only ▶

12 bits of the word.

The Instrument tables, of which there are 16:

silence,
attack 1, sustain 1, decay 1,
attack 2, sustain 2, decay 2,
attack 3, sustain 3, decay 3,
complete notes 4 to 8,

and have three bytes per stage: 12 bits (ie 1½ bytes) for pitch offset, four bits (the other ½ byte) for a stage count (ie how many times that stage of the envelope should be repeated), and one byte for volume.

Two other tables are used by the runtime routine. A utility table, where it keeps its pointers to its position in the tune and envelopes, and a PSG register buffer, where it assembles the data before writing it to the PSG all in one go.

ARE YOU BEING SERVED?

The system works as follows. The BASIC calling program passes the pointers to the start of each voice's music data, by placing the addresses into the utility table. The runtime routine then cycles through the following process. It looks at each voice in turn to see whether the data requires updating. If so, it updates and places the result into the PSG register buffer. If no action is required, it passes via a delay loop which takes exactly the same number of machine cycles as the active updating would have taken. This process is called Serve. At the end of six Serves the whole contents of the PSG register buffer are written to the PSG by the routine called Load. Finally, before repeating the process, the keyboard is checked to see whether any kind of key has been pressed. If it has, the volumes of all three channels are set to zero, and the routine ended. A flowchart of this process is shown in Fig. 12.

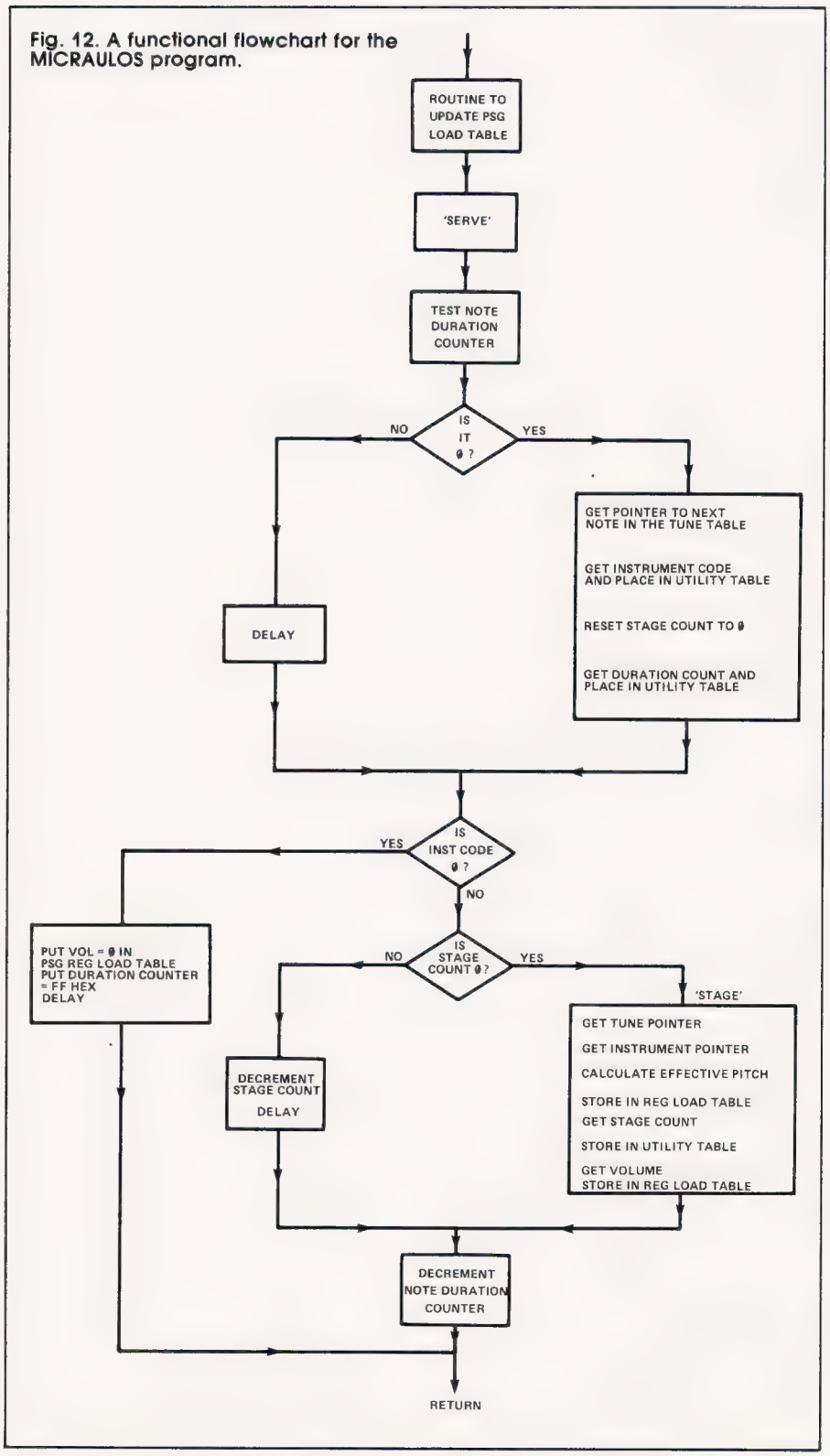
The compiler, written in BASIC, is modular and consists of a number of routines, called on when necessary in the course of the main program loop. These routines are:

1) Initialise
2) Input key and time signature information.
3) Input a note and translate parameters.
4) Display the entered note.
5) Make a space at the end of the relevant voice by moving the following tables on by four bytes.
6) Insert the note parameters into the appropriate position in the table.
7) Delete a note by moving the following tables back by four bytes.
8) Find a place in the code for editing, by converting an entered bar and note number.
9) Calculate changes required in the notes in the table when one of them has its duration changed in the course of editing.

POINTS TO NOTE

The most difficult decision in writing a program to input music is: how shall the notes be represented. A musical note has a name, an octave in which it is played and a duration. In the absence of a peripheral like a light pen or graphic tablet, the important thing is to try to minimise the number of keystrokes required to represent the note. In MICRAULOS, name, octave and

Fig. 12. A functional flowchart for the MICRAULOS program.



duration are entered as abbreviations, but the parameters will all default to their previous values if only a Carriage Return is entered. Equally, because of the graphic limitations of the standard NASCOM, the display of the notes is alphabetic rather than in musical notation, although the duration of the note is represented in the display by a series of dots.

The system as described will allow quite a few minutes of music to be entered before it runs out of memory. It is, however, not so much a polished piece of commercial software as a useful working tool. I would still prefer any day, to listen to music produced by real instruments — but just as it was said that the battle of Waterloo was won on the playing fields of Eton, the success of at least one of my sons at his Royal College of Music violin exams, grades 1 to 4, is at least partly attributable to the ability of MICRAULOS to play the same accompaniment at any chosen speed, faultlessly, untiringly and uncomplainingly, over and over and over again.

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ELEGANT PROGRAMMING

Writing structured programs not only depends on the careful and considered use of the correct methods but also requires the use of the correct data structures.

The idea that a program consists of two parts — actions and objects — was introduced right at the beginning of this series. However, up to this point we have only examined the way the actions could be specified. In other words, we have only looked at the subject of program structure. Now it is time to consider the other side of the coin — data structures. Although data structures have been left until after a discussion of program structure, this shouldn't be taken to imply that they are any less important. There are two distinct ways of producing 'objects' for programs to operate on. First, there is a range of simple or fundamental 'data types' which programs can use for calculations, etc. Second, there are ways of taking these fundamental data types and putting them together to make ordered arrangements. Ways of arranging simple data types into larger objects are usually called 'structuring methods'. For example, a character is a fundamental data type, but an array is a structuring method because you can define arrays of numbers or characters.

REPRESENTATIONS

As most programmers know but often forget, the only sort of data which a computer can deal with directly takes the form of a binary number. The reason why it is so easy to forget this elementary fact is that it is the purpose of a high-level language to extend the range to include more exciting and useful forms of data and so hide the strict limits of the hardware from its programmers. This is a good thing because the largest binary number which most micros can deal with in one go is only eight bits or, in other words, in the range 0 to 255. Clearly, to be able to do anything useful, it is necessary to use this very limited form of data to represent every type of 'object' that we would like to write programs about. Although this sounds like an awesome task there are in fact, only two fundamental types of data and everything else can be produced by organising these. The two fundamental types correspond to the two types of numbers in common use — integer and real numbers.

Integers are the simplest type of number that we use on a regular basis. An integer is a whole number; for example, 3, -3 and 0 are all integers whereas 3. 14 -3.8 and 3.0 are ***not*** integers.

The idea of integers and real numbers is something that most programmers meet in one form or another even in high-level languages. However, it is quite possible to use some versions of BASIC and never be troubled by the difference between numbers with fractional parts and numbers without fractional parts. Indeed, one of the strongest of BASIC's many good points is that if you don't want to know about such things then you can ignore them almost completely.

It's beginning to sound as if introducing two different types of number into computing is unnecessary and that other languages should follow BASIC. This is to some degree good sense, in that there is a lot to be said for protecting the user from unnecessary complications. However, even BASIC has to admit that it is sometimes important to be able to convert a real number into an integer and normally provides the function INT which will round a real value down to give an integer.

FUNDAMENTALLY . . .

Integers are the most fundamental of all the data types and are the starting point for everything else, so it's not surprising that they cannot be avoided completely. For example, if you want to extend the range of data types to include the usual printed characters, then the only way that this can be done is to assign an integer to represent each different character. Such assignment of integers to characters is known as a character code (probably the best known of which is the ASCII code) but it is important to realise that it is not the only one in use.

No matter what you may be led to believe, you cannot store a character inside a computer — merely an integer that represents it.

The pair of BASIC functions CHR$ and ASC (or CODE in some dialects) make the connection beween integers and characters clear. CHR$(I) returns the character whose code is the integer I, and ASC(C$) returns the code of the character stored in C$. Apart from just being a way of storing characters inside a computer, the way that integers are assigned to characters also governs the results of comparisons. For example, "A"<"B" is true *only if* ASC("A")<ASC("B") is true. In other words, the order of the character set is simply a reflection of the order of the integers in the character code.

SCALARS

In the same way that integers can be used to extend the range of data types to characters, they can also be used to represent other equally simple 'objects' — the scalars. A data type is a scalar if the values that it can take on are 'countable'. You may at this point find the idea that a data type can take on values which are un-countable a little difficult to comprehend but, as we shall see later, this is entirely possible.

The only two scalars which most versions of BASIC recognise are characters and the Boolean data type which has the two values 'true' and 'false'. A Boolean data type is the result of any sort of comparison. For example, 'X>0' is either true or false depending on what is stored in X. As with the characters, the values true and false are stored by assigning each one to an integer. Which integers are used depends on the dialect of BASIC, but 0 for true and −1 for false is quite common. Some versions of BASIC try to cover up this use of integers to represent Boolean data by not permitting you to use the results of Boolean expressions in arithmetic or PRINT statements but many will allow you to write things like:

```
PRINT (2=3),(2=2)
```

which will first print the integer which represents false and then prints the integer which represents true. (It is worth trying this line of BASIC as a simple experiment to see what your version of BASIC makes of it.) An unwanted side effect of the use of integers to represent 'true' and 'false' is that, in the same way as the characters 'take up' the order of the integers which represent them, so do the two values true and false. Let us suppose that true is represented by −1 and false by 0 (the representation used by Microsoft BASIC -80). In this case, 'false' is greater than 'true' and if 'x' and 'y' are a pair of comparisons which are either true or false then we can draw up the following table to show the results of x not equal to y.

x	y	x< >y
false	false	false
false	true	true
true	false	true
true	true	false

If you look closely at this table you should be able to recognise the truth table for exclusive OR!

WEEK ENDING

BASIC may not provide other scalars as standard data types but BASIC programmers certainly make use of them. For example, if you want to write a program that records the day of the week that something happens to you, you might start by assigning a number to each day, ie Monday = 1, Tuesday = 2 and so on. By assigning integers in this way you are creating your own data type — days of the week. Some computer languages, Pascal for instance, have special facilities allowing the introduction of new scalar data types in such a way that you can write satements such as:

```
day=friday
```

It is sometimes said that one problem with BASIC is that it cannot cope with user-defined scalars in this way and has to resort to statements such as:

```
day=5
```

instead. In fact, it is simple write programs in BASIC which make user-defined scalers easier to understand by defining variables with appropriate names and values. For example, (assuming the version of BASIC you are using can handle long variable names) given the following list of definitions:

```
10  MONDAY=1
20  TUESDAY=2
..  .....
..  .....
70  SUNDAY=7
```

you can write something like:

```
100  DAY=FRIDAY
```

and:

```
110  IF DAY=MONDAY THEN PRINT "First
     day of the week"
```

This simple use of variables to store the integer codes assigned to each value of the new scalar type gives BASIC nearly everything which languages such as Pascal have except the automatic checking for nonsense such as:

```
day=8
```

The above statement is something which an application program should pick up before it happens anyway! Using this method you can even write things like:

```
10  FOR I=MONDAY TO FRIDAY
20  PRINT "WORKING DAY"
30  NEXT I
```

or even

```
10  FOR DAY=MONDAY TO FRIDAY
20  PRINT "WORKING DAY"
30  NEXT DAY
```

The data type scalar — encompassing integers, characters, Boolean and any user-defined scalars — is the most commonly encountered and most useful data type in BASIC or any programming language. Indeed, it is difficult to think of applications which don't use scalars apart from those involving nothing but long numerical calculations.

BACK TO NUMBERS

The importance of scalar types is a reflection of the fact that, contrary to popular opinion, computers don't spend much of their time doing 'different sums' but are more often busy moving non-numeric data from one place to another and making decisions. However, it would be a mistake to ignore the problems involved in using numbers and doing arithmetic on computers completely. Even in a high-level language it is helpful to know what is going on!

A more difficult problem is the storage of numbers ***smaller*** than zero — in other words, negative numbers. There are many ways of extending the range of integers to include negative numbers, but all of them involve a little mathematics to be fully understood. Fortunately, all the BASIC programmer has to be aware of is that to accommodate negative numbers, it is necessary to split the range of numbers which can be stored into two — the first half is considered positive and the second half negative.

Storing and using integers is only complicated by needing to use negative numbers and needing a large enough range to avoid overflow errors. However, storing real numbers is considerably more difficult. The point is that if you can store an integer then you can store it exactly, but no matter what scheme you choose to store real numbers there will always exist numbers that you cannot cope with.

For any two real numbers there is **always** *another which lies between them.*

This is clearly not true for integers — after all what integer lies between 2 and 3! This observation should also indicate that real numbers are not simple scalars as it is not possible to count how many reals there are in the same way that you can count how many days of the week there are. Another difference is that for a simple scalar there is the concept of 'next', ie the next day of the week, the next integer after 2 (ie 3), and so on; but for reals, there is no such concept of 'next'. Consider for a moment, what is the next real number after 2, is it 2.1, or 2.01. or . . .? All of this should convince you that there are integers and their associated family of simple scalar types and there are the reals, and both present their own particular set of problems.

REPRESENTING REALS

Before going on to consider the sort of problems that real numbers cause in everyday BASIC (and other high-level languages) it is worth spending a little time considering how real numbers can be represented inside a computer. The most obvious way of representing a real number is to change an integer to a real by assuming that there is a decimal point written after a particular bit of the number. For example, if you assume that an eight-bit number is in fact made up of four bits, a decimal point and followed by another four bits, then 10101011 would represent a real number given by 1010.1011. Notice that the decimal point isn't stored inside the computer, we just remember where it is when interpreting the contents of a memory location. Although the dot written in the middle of the number has been referred to as a decimal point, it is more correctly called a binary point!

If you try to work out what real number 1010.1011 represents, you should have no trouble with the first part as 1010 is easily converted to ten using the usual method for changing from binary to decimal, but what about the part following the binary point? In the same way that the values increase by a factor of two for every place to the left of the binary point, they decrease by a factor of two for every place to the right of the binary point:

```
8  4  2  1     ½  ¼  ⅛  1/16
1  0  1  0  .  1  0  .  1
```

This gives a value of $8+2+\frac{1}{2}+\frac{1}{8}+\frac{1}{16}$ or the entire number, or in other words, 10 and $\frac{11}{16}$ or 10.6875. This sort of representation is known as 'Fixed point' and it was very common in the early days of computing. However, it suffers from the problem of not being flexible enough for general use. The trouble is that it simply cannot cope with the range of numbers use in calculations, especially scientific calculations.

The solution is to abandon the usual decimal point notation altogether in favour of the so-called 'exponential' or 'scientific' notation. This separates a number into two parts, the first — the exponent — giving the overall magnitude of the number, and the second — the mantissa — giving the most significant digit of the number. In normal use a number is written in exponential form as:

```
'mantissa' E 'exponent'
```

and can be converted to the more usual decimal form by:

```
number=mantissa*10^exponent
```

Where ^ is to be read as 'raised to the power of'. So .43E3 is .43 * 1000 or 430 and .321E-2 is .321 * 0.01 or .00321.

Using this format a wide range of numbers can be represented. When used as a method of storing real numbers inside a computer it is usually called 'floating point' representation rather than exponential, but it essentially the same. The exponent is stored as an integer in one memory location and the mantissa is stored as a fixed point number in several other locations. The exact details of how this is done varies from BASIC to BASIC but all that should concern the BASIC programmer is:

— how many digits or bits are used for the mantissa

and:

— how many digits or bits are used for the exponent.

These two factors govern the accuracy and range of numbers which a BASIC program can handle. For example, Microsoft BASIC-80 uses three memory locations for the mantissa and one for the exponent — this gives about seven digits of precision and a range of about 10^{38} to 10^{-38} (both of which I find difficult to imagine!).

PUT TO GOOD USE

The fact that some BASIC's don't even bother to distinguish between integers and reals has already been mentioned, but this doesn't mean that we can throw caution to the wind and treat reals and integers in the same way. Some versions of BASIC do provide a range of differnt types of number and hence variables. For example, both Microsoft and BBC BASICs provide integer variables (indicated by a '%' sign at the end of the variable's name). As any arithmetic with integers is a lot simpler than for reals, the use of integer variables is often to be preferred to reals. To see if your BASIC works faster with integer variables, time the following programs:

```
10  K=0
20  K=K+1
30  I=K*K+K/K
40  IF K<1000 THEN GOTO 10
```

and:

```
10  K%=0
20  K%=K%+1
30  I%=K%*K%+K%/K%
40  IF K%<1000 THEN GOTO 10
```

There are other advantages to using integer variables apart from speed. In particular, if you are trying to write programs which handle money, it is comforting to know that integer variables will keep track of the last penny!

More seriously, it is important to realise that real variables cannot carry out calculations exactly. For example, try the following program:

```
10  K=0
20  K=K+1/7
30  IF K=1 THEN STOP
40  GOTO 20
```

On most versions of BASIC this program will never stop although you would expect it to end after adding $\frac{1}{7}$ to K exactly seven times. To see why, add the line:

```
25  PRINT K
```

and run the program again.

Because of difficulties with accuracy, you should never compare real numbers in IF statements. Instead of:

```
IF A=B THEN ....
```

use:

```
IF ABS(A-B)<C THEN ....
```

Where C is small enough to ensure that A and B are close together when the condition is true and yet large enough to ensure that the condition is true when the difference between A and B is about the same as the accuracy they are stored in.

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PRODUCT / FEATURE	DRAGON 32	SINCLAIR SPECTRUM	ACORN ATOM	VIC 20	TI 99/4A	BBC MICRO 'A'
PRICE	£199	£125	£175	£190	£199	£300
STANDARD RAM SIZE	32K	16K	8K	5K	16K	16K
STANDARD AVAILABLE RAM FOR HIGH RESOLUTION GRAPHICS	26K	9K	N/A	N/A	14K	3K
EXTENDED MICROSOFT BASIC AS STANDARD	YES	NO	NO	NO	NO	NO
PROFESSIONAL-TYPE KEYBOARD	YES	NO	YES	YES	YES	YES

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SPECIAL REPORT

We get into the swing of things and tune up on Fairlight's musical micro.

When you consider the apparent dichotomy between the Sciences and the Arts, it may surprise some of you to learn just how far computer technology has infiltrated the world of music. Over the last decade, various musical 'instruments' such as the synthesiser have been quick to exploit the advantages of microelectronics but few have delved deeper. But now, the tide is turning, and riding the crest of the wave is the Fairlight Computer Musical Instrument.

Development on the Fairlight CMI began about three years ago and was initiated by a small company in Sydney, Australia. Eager to improve on their previous product — the QASAR M8, an eight waveform channel polyphonic system — its designers, Peter Vogel, Kim Ryrie and Tony Furse, set out to produce the Fairlight. Six months later, the prototype was completed — a musical instrument which could create sound in a totally digital fashion.

PLAY YOUR CARDS RIGHT

The basic CMI package comprises a computer unit, an alphanumeric keyboard, a six octave musical keyboard and a graphics display unit.

Looking inside the computer unit, there are a number of cards all configured in a modular design. The first card is a master card controlling the eight voice channel cards; each of the voice cards contains 16K RAM dedicated to the waveform memory, and a D/A converter. The next card along controls the light pen and this is followed by the 64K card; the system supports 208K RAM in all. Next up comes the CPU control card which incorporates a serial and parallel interface as well as 2K of ROM used to 'boot up' the system disc.

Perhaps the most important card of all is the central processor module. This card includes two 6800 processors connected back to back, allowing each to utilise the same areas of the memory available without interrupting each other. This system of operation was used on the QASAR M8 and is fundamental to the feasability of the Fairlight as a working musical instrument.

The last two cards in the computer unit control the disc drives and the graphics display. The disc drives are actually built into the computer unit; both are 8" drives and operate via direct memory access for high speed. Originating from Japan, one of the discs is the system disc supplied with the Fairlight, and the other is the user disc which awaits whatever creative sounds you wish to enter on it; both discs are capable of storing up to ½M. Whenever the Fairlight system disc is updated, users of the instrument receive the new disc free of charge — a nice touch!

The graphics controller card provides the impressive memory mapped display of 512 by 256 points and includes a further 16K RAM. The high resolution graphics are easily accessible with the light pen. For further expansion using special interfaces, there are four extra slots available.

IN THE MOOG

The musical keyboard consists of a six octave keyboard with three controls for fading and volume, and a keypad with its own alphanumeric display. The keyboard itself incorporates a 6809 processor which actually calculates all the information received from the keyboard. Each octave of the keyboard can be individually programmed with a different sound and there is also the option to use a slave keyboard so that one particular sound can be allocated to the master keyboard while still keeping the other sounds available on the slave.

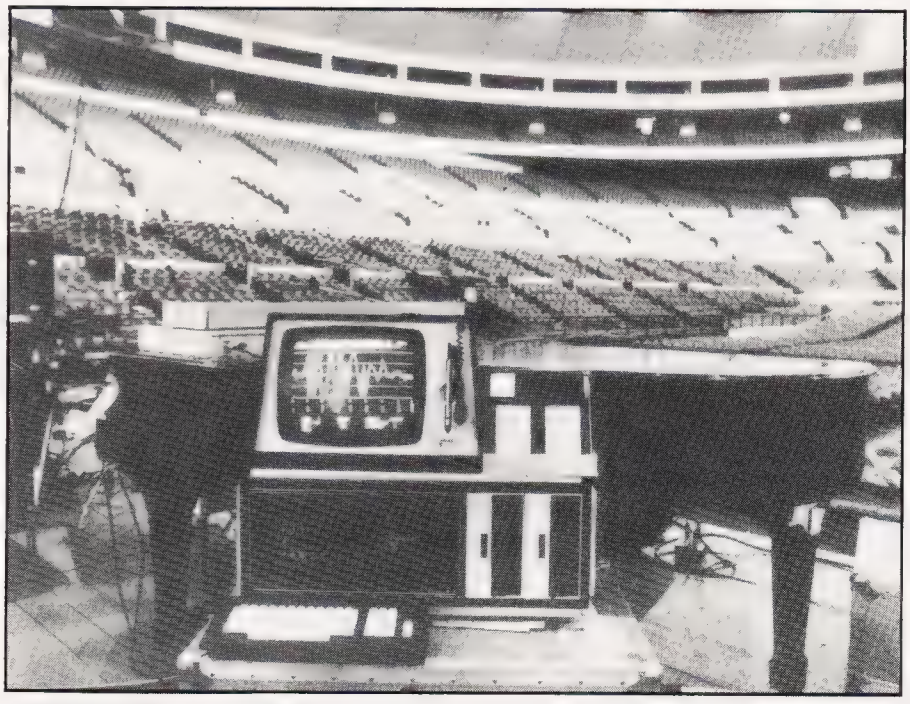
Future developments to the Fairlight include the possibility of a new keyboard specially designed by Robert Moog (of Mini Moog fame). The projected keyboard is to have a dynamic 'feel' to it allowing the user to form different textures of sound simply by applying subtle pressure to the keys themselves (in a similar way to a piano keyboard).

MAKING MUSIC

Moving away from the hardware of the machine brings us to the software side. There are 12 display pages available on the monitor to the user, each offering various facilities. The first page, as you would expect, provides an index as to what is contained on the other 11 pages.

Looking first at the pages concerned with music generation, there are four ways of creating music on the Fairlight. (You must remember that the Fairlight has no 'sound' of its own, all the sounds have to be programmed in.)

Starting with Page 4 (Harmonic envelopes), you are presented with 32 vertical lines, each representing harmonic quantities. Using the light pen, you can simply create your own sound by first drawing the harmonic profile giving the overall



Fairlight's CMI — in concert!

ROLL OVER BEETHOVEN

When you compare the complexities of musical notation involved in the composition of a piece of music with the structure of a computer language, it is no wonder that the Fairlight CMI includes a specially adapted computer language to write music. Music Composition Language (MCL) provides the means of inputting musical data via the alphanumeric keyboard, storing the program and then replaying the data as sound.

The data is built up by specifying the various parameters of each note: the pitch, velocity, duration and time between each note — repeats can be achieved through programming thus quickly building up your musical piece. Once stored, the sounds can also be manipulated using the facilities offered by Page 7.

◀ **Page 8 (Sound sampling in action.**

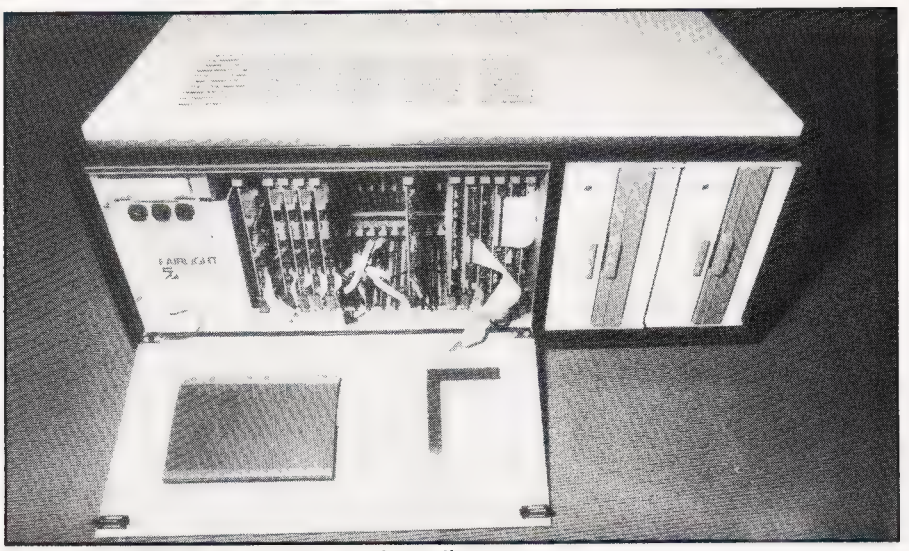
amplitude change over the cycle, and then plot the duration profile to determine the duration of each segment of the 32 segment cycle. Thus, the sound created is not only original but will vary dynamically over the entire segment over part or all of the time the key is pressed. There is also a loop facility which allows you to select wavegroups and then repeat them as long as a particular key is pressed.

Supposing you don't like the sound you have created with this method, the Fairlight offers you a multitude of ways to help you manipulate the sound into something a little more pleasing. For example, Page D provides the facility for you to see a 3-D representation of your sound and Page 5 (Waveform generation) allows you to change individual harmonic amplitudes to your own specification.

Another way of making music on the Fairlight involves the use of Page 6 (Waveform drawing). This is similar to the method employed by Page 4, but instead of manipulating the individual harmonics to create the sound you require, you can simply draw the waveshapes you want and let the CMI work out the harmonic values. Using this method, the construction of square and triangular waves is obviously a lot easier than working from harmonics.

Several other functions can be used with this page such as Merge, which will mix selected parts of the waveform, Reverse, which is used to create a 'backwards' sound, and Reflect, with which you can reflect selected parts of the waveform.

Page 9 (Sequencer) can also be used in conjunction with this page allowing up to 30 minutes of musical data to be stored on the user disc. Up to eight monophonic tracks can be recorded with a 'click' track available for the user to solo over the top. As all the tracks are recorded digitally there is little or no distortion or degradation as the voice channels are built up.



A look inside the Fairlight's computer unit.

Possibly the most creative area of the Fairlight is available through the use of Page 8 (Sound sampling). Using this facility any audio output can be sampled, stored and then played back via the keyboard. Of course, care must be taken to ensure that the original sample was not clipped and a full cycle of the waveform stored, but with these provisos, any sound can be used — from a hand clap to a dog's bark. Once the sound is stored on the user disc, it can be further manipulated by the facilities available on Page 7 (which will be dealt with at a later stage).

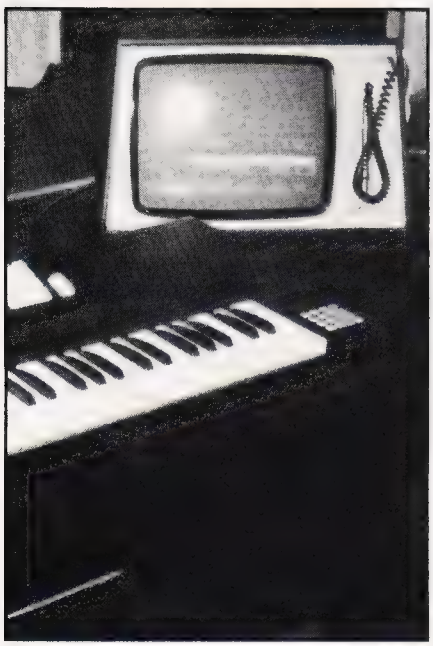
Having mentioned Page 7 (Control parameters) a couple of times, it would be useful to explain its function. It essentially provides the means to 'finish off' any sound. The user can specify the attack and decay speeds, glide and sustain, the overall level of the sound and includes a low pass filter to adjust the tonal quality. In addition to this, the page can also be used to treat the sound for equalisation, reverb and various effects. Special hardware interfaces are also available allowing the Fairlight's abilities to be harnessed by other input devices, a guitar for example.

Looking back over some of the other pages, we first come to Page 2 (Disc control). This page provides a menu of all the files currently on the user disc allowing the user to delete, load and transfer any file. Page 3 (Keyboard control) allows the operator to allocate various sounds to particular octaves of the ▶

keyboard. In this way, each octave area of the keyboard can be allotted a different sound; the slave keyboard can also be controlled at this point providing even more sounds at your fingertips.

The last page on the menu is Page L (Disc library) which gives the user access to the disc file menu via the 16-key scratchpad inset into the keyboard. This allows the musician in a 'live' situation to simply load and store various voice channels and instrument files without having to get confused with the alphanumeric keyboard. (If you're wondering at this stage how anyone could begin to comprehend the workings of each page, typing HELP at any stage provides a complete explanation for the experienced and uninitiated alike.)

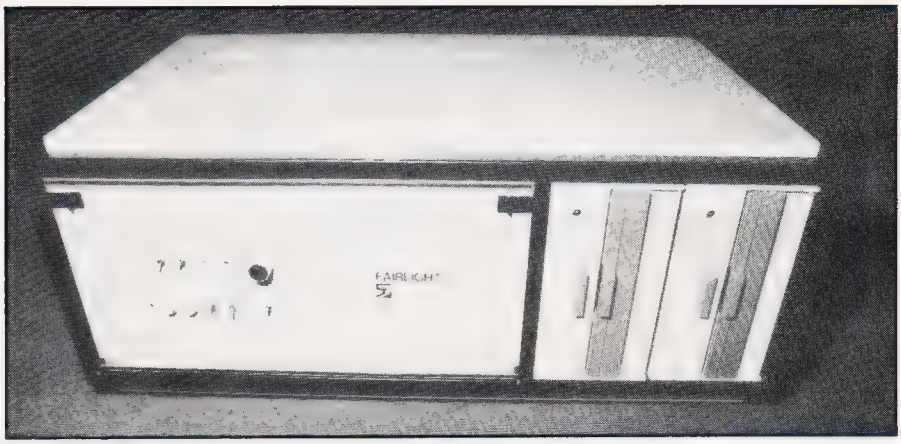
Although not yet part of the Fairlight's impressive array of pages, a new page is currently nearing completion. To be called the Rhythm pattern sequencer, the page allows notes to be entered into hundreds of unique patterns or rhythm



sequences which are then played together indefinitely. The resulting rhythmic music is as impressive as it is quick to produce. All the notes are displayed as they are played and inaccuracies can be edited on the screen.

THE LAST WALTZ

As an instrument for the individual composer to sit and 'think aloud', the Fairlight CMI must be considered the ideal candidate. As for 'live' appearances, however, I would have thought the device far too complex — Led Zeppelin, Yes, Stevie Wonder, Bad Company and Helmut Van Karajan with the Berlin



Philharmonic (to name but a few) seem to have had little problem touring with the CMI though!

You may at first think that £18,000 is a lot to pay for an instrument. Well, it is — but also consider the cost of other instruments, session musicians and studio time and you will see that in perspective, the price becomes more reasonable. The suppliers of the Fairlight, Syco Systems, are the first to admit that the CMI will not replace all other known instruments — but then what could replace a £70,000 'cello? Or the sweet sound of a Stradivarius?

Many microcomputers proudly boast their musical ability but they are primitive compared to what can be achieved on the Fairlight. But if the CMI is, as they say, the shape of things to come, given a few years the home computer market could be in for a musical treat!

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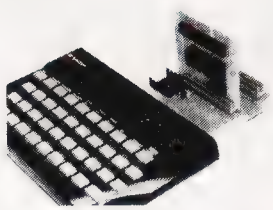

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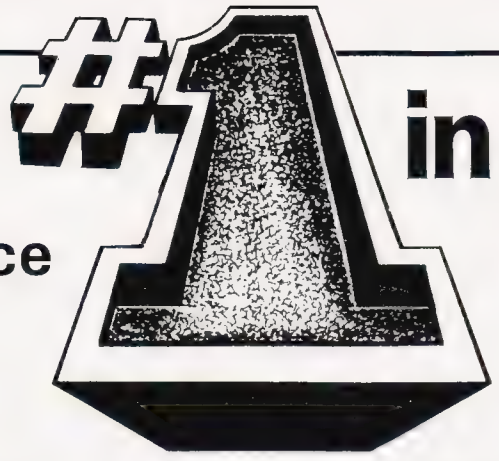

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Computing Today

INDEX '82

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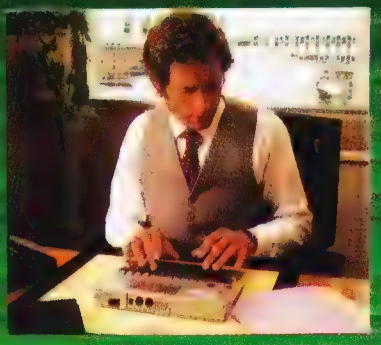
Imagine a totally portable computer that slips into your briefcase, incorporating an LCD screen, full typewriter keyboard, printer and microcassette, and runs on its own power supply for use anywhere.

We did.



HX-20
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EPSON
Extraordinary product.
Exceptional quality.

The HX-20. The most complete portable computer available today.

Taking the computer a step further.

A computer small enough to fit into a briefcase yet with full size typewriter keyboard, LCD Virtual Screen, printer and microcassette facility actually built in.

Improbable. Until today.

Functions fantastic.

The HX-20 is a real computer, not a gimmicky toy. Or an extension of your calculator. Or just another desk top computer. It is a precision machine with 16k RAM which is optionally expandable to 32k and 32k ROM expandable to 64k, RS-232C and serial interfaces.

The full size ASCII typewriter keyboard and five programmable keys brings ten separate program functions to your fingertips.

The HX-20 can run on its own power supply for over 50 hours which can be easily recharged overnight, and has the ability to retain its memory in RAM even when switched off.

Virtual Screen keeps you in the picture.

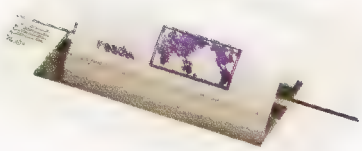
The HX-20's LCD Screen is unique, keeping you in the picture by showing any 20 characters by 4 lines at a time. You can, therefore, carry out word processing or data entry as if you are using a large screen.

Upper and lower case letters, numerals, punctuation marks and graphics are easily read by simply adjusting the viewing angle.

Print out. Built in.

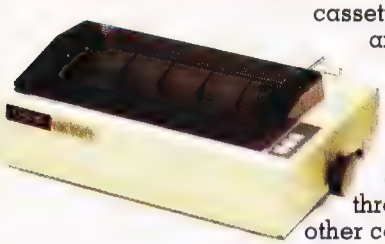
A built-in 24 column dot matrix impact microprinter offers 42 LPM in a crisp, precise 5 x 7 matrix for perfect hard copies on plain paper. Every time.

And there's more. . .Bit addressable graphics allow you to design your own characters for full graphic capability, a cartridge ribbon, full ASCII character set including £ sign and enough international symbols for reproducing most Western languages.

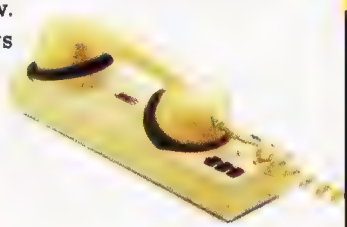


Add-on capability.

Choose from a wide range of peripherals. Barcode readers, audio cassette for loading and saving programs, microcassette and ROM cartridges, and the world famous Epson dot matrix computer printers for quality output . . .to name just a few.



Via acoustic couplers this superb machine can also be linked through the telephone to other computers.



Software and the hard facts.

The HX-20 uses a full extended version of Microsoft BASIC, with a 24 hour clock, date and alarm, string functions, and music generation. The interface options (with RS-232C and serial interfaces as standard) include a standard cassette, a ROM cartridge, plus a system bus that allows you to expand the RAM and ROM capabilities.

Portability for Programability. Anywhere.

The HX-20 is light and totally portable for writing programs and manipulating data – virtually anywhere. (Just four nickel-cadmium batteries and a low power all-CMOS memory gives you a reliable power source during your travels.)

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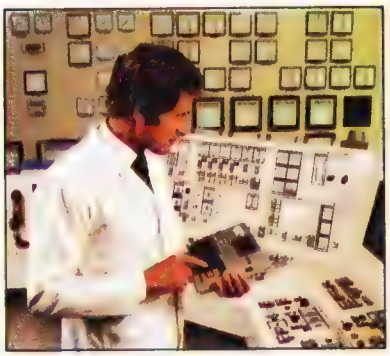

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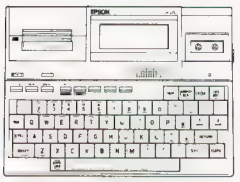
Specifications of HX-20

Dimensions and Ambient Conditions

Dimensions and Weight

1. Dimensions:	290mm wide 215.5mm deep 44mm high
2. Weight:	Approx. 1.7 kg



Ambient Conditions

1. Temperature:	5°C to 35°C (operating) 5°C to 35°C (charging) –5°C to 40°C (data storage) (RAM battery backup) –20°C to 60°C (non-operating)
2. Relative humidity:	10% to 80% (operating, no condensation) 10% to 80% (non-operating, no condensation)
3. Shock resistance:	1 G for 1 ms maximum (operating)
4. Vibration resistance:	0.25G 55 Hz maximum (operating)

Power Supply (Nicd batteries)

1. Voltage:	4.5V to 6.0V (operating) 4.0V to 6.0V (data storage) 4.5V (low voltage detection)
2. Battery capacity:	Approx. 1100 mAH

AC Adaptor

1. Input voltage:	AC 220V/240V ± 10%
2. Power consumption:	8W
3. Insulation resistance:	10megohms between AC power supply and case
4. Insulation strength:	Can withstand 1 kV applied between AC power supply and case for 1 minute or more

Microprinter (M-160)

1. Printing system:	Dot impact (4 printing solenoids)
2. Printing format	
a. Total number of dots:	144 dots maximum/dot line
b. Number of characters per line:	24 maximum (5 x 7 dots; character-to-character space 1 dot) (6 characters/printing solenoid)
3. Printing speed	
a. 1 dot line:	Approx. 150 ms (continuous printing)
b. 5 x 7 dot matrix (interline space 3 dots):	Approx. 0.7 line/s (continuous printing) 42 lines per minute
4. Character size	
a. Dot spacing:	0.33mm horizontal 0.33mm vertical
b. 5 x 7 dot matrix:	1.7mm wide, 2.4mm high
5. Recording paper	
a. Kind:	Plain paper
b. Paper width:	57.5 ± 0.5mm
c. Outside diameter:	50mm or less
d. Thickness:	0.07mm
e. Weight:	52.3 g/m^2 (45 kg/1000 sheets/1091 sheets x 788mm)
6. Paper feed:	Automatic feed every dot line; with paper release
7. Inking	
Ribbon cartridge type	
Automatic continuous feed during motor operation	
a. Colour:	Purple/Black
b. Dimensions:	Approx. 91mm wide, 25mm deep, 7mm high
c. Life:	Approx. 10,000 lines
d. Standard:	ERC-09

Liquid Crystal Display

1. Text:	Upper and lower case, numerals, symbols, graphic characters and more; 20 characters per line; 4 lines in total (20 x 4 = 80 characters)
2. Graphic:	120 dots (horizontal) x 32 dots (vertical) = 3840 dots
3. View angle adjustment:	Adjustable with VIEW ANGLE density control

Keyboard

1. Key switches:	Typewriter layout, full size. 68 keys (including 5 function keys and 13 special keys)
2. Others:	Power on switch, VIEW ANGLE density control for LCD, and adjusting circuit built in

RS-232C Interface

1. Connector:	DIN (8-pin) TCS 4480
2. Input and output levels:	RS-232C standard
3. Transfer speed:	110, 150, 300, 600, 1200, 2400, 4800 bps (selectable by operator)

Serial Interface

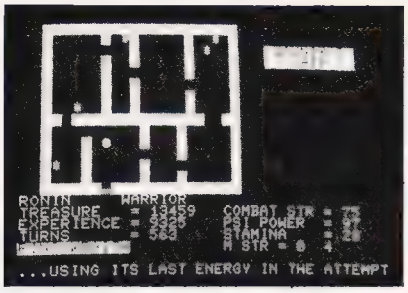
1. Connector:	DIN (5-pin) TCS 4450
2. Input and output levels:	RS-232C standard
3. Transfer speed:	38, 150, 400, 600, 4800 bps (selectable by operator).

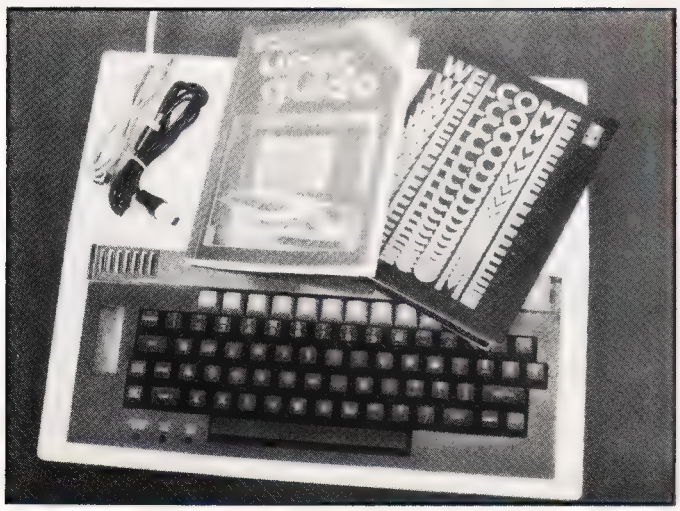
HX-20
PORTABLE COMPUTER

EPSON

Epson (UK) Limited
Dorland House
388 High Road Wembley
Middlesex HA9 6UH
Telephone: 01-900 0466/9
Telex: 8814169

Into The Valley
April p51





The BBC's Micro March p55

Osborne's One June p39

A Sirius system?
December p69

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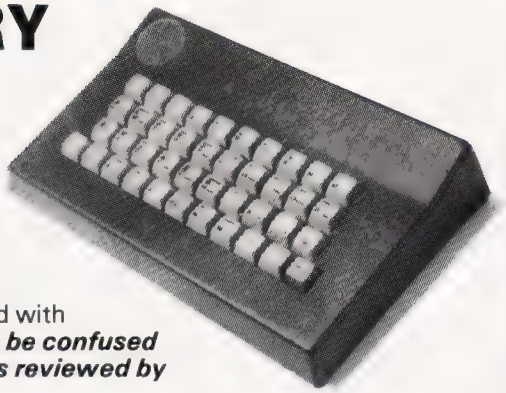

These highly professional keyboards incorporate executive buttons similar to those used on top-quality computers. A repeat key facilitates entering of characters much faster than is possible with a conventional keyboard, thus making it particularly ideal for cursor control and erasing. Attractive black plastic moulded case. Supplied with 12'' flexible ribbon cable for connection into your computer. ***Not to be confused with toy keyboards currently on the market. Other attributes as reviewed by Tim Hartnell, ZX Computing/Interface.***

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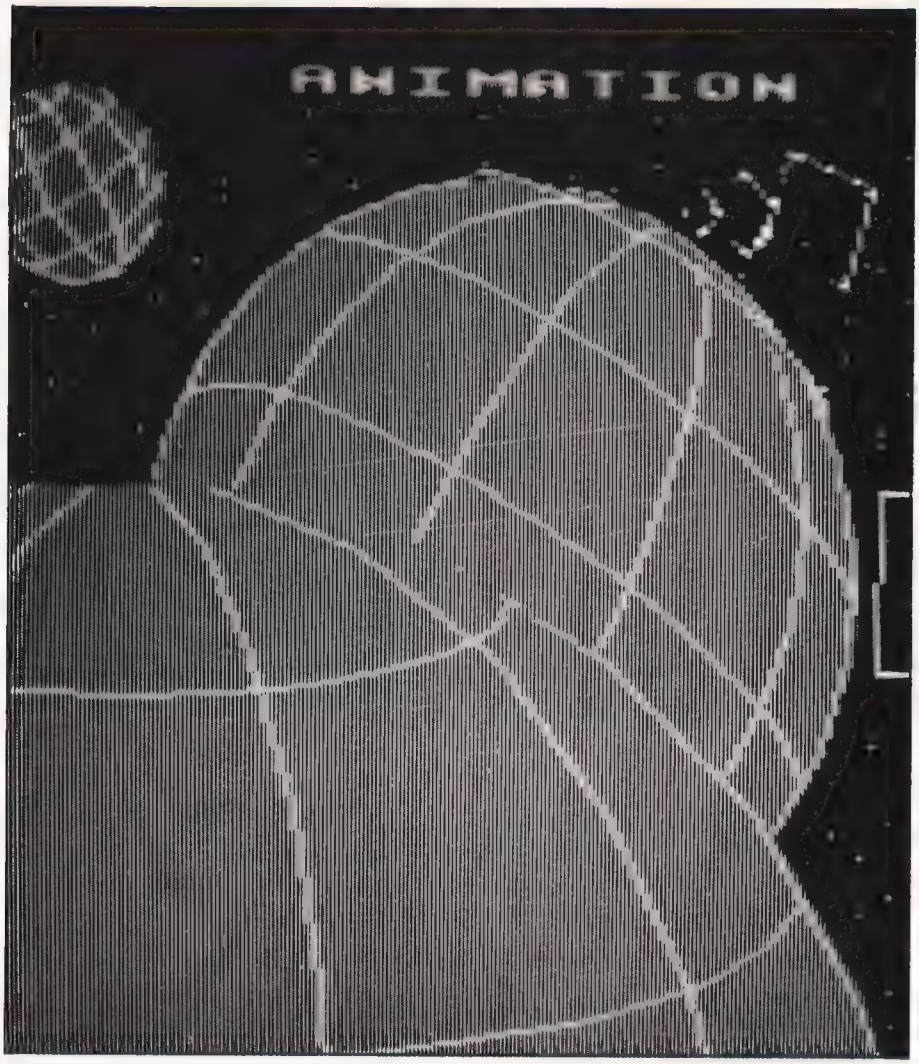
3-D ANIMATION

A program that boldly goes where no program has gone before.



A couple of years ago I went to see the science fiction film, **Alien,** and was most impressed by the computer graphics sequence in which a spaceship was landed on an unexplored planet with the aid of a rather futuristic navigational computer. This, I thought, was the quality of graphics which I would like the microcomputer I would buy to be capable of producing. However at the time high-resolution colour graphics were an expensive luxury available on relatively few machines, and it was not until the advent of micros like the BBC Micro that Hi-Res entered the low-cost market.

As an exercise, shortly after buying my Model B BBC Micro, I set myself the task of writing a program which would mimic the display of the Nostromo's navigational computer. On my second attempt I wrote ANIMATION, a typical screen of which is shown in Fig. 1. Four spinning planets are displayed in symbolic form as blue spheres, on which the lines of longitude and latitude are drawn. Several hundred stars drift across the screen in the background, creating the impression that the observer is moving with the planetary system, relative to the sidereal frame. Meanwhile, the ship's flight-path is indicated by a series of square boxes shooting from the foreground away into the far distance, changing course and rotating as they go, before finally vanishing at the pole of the destination planet.

THE ANIMATION TECHNIQUE

The first version of ANIMATION took the most obvious, but rather naive approach. The idea was to make, for example, the stars appear to move by repeatedly deleting them and redrawing them in slightly different positions on the screen. The main problem with this was how to deal with stars which go behind a planet, and then re-emerge on the other side. There was also the question of speed! It took so long to shift roughly 300 stars around the screen that, far from being fast and smooth, the star's motion was very slow and jerky. This method might work on the ICL mainframes used by the producers of **Alien,** but eight-bit micros are simply not fast enough.

I then stumbled across the remarkably elegant animation technique which I was eventually to employ. It makes use of a facility of the BBC Micro to redefine 'logical to actual colour relationships'. To explain, suppose you draw a ball on the screen in logical colour 1, which is red by default. Now, suppose you decide that you want the ball to turn green. You can do this very easily with the command VDU 19,1,2;0; which tells the computer that colour 1 is now green. You can make the ball disappear by turning it black with VDU 19,1,0;0; and make it reappear in red again with VDU 20, which just resets all the

default actual colours. Not that the contents of the screen memory have not been changed — the computer has merely been instructed to interpret them in various different ways. This ability to make objects disappear and reappear, without access to the screen memory, is the crux of the technique.

For example, suppose we define logical colours 1-15 to be black, then we draw 15 balls on the screen, each in a different logical colour, as shown in Fig. 2. Now, we define colour 1 to be yellow, pause for a moment, then re-define it as black. The process is repeated with colours 2-15 in turn. If we do this at the right speed we produce the illusion that there is a single yellow ball, moving from left to right. The beauty of the technique is that once you have set up the screen memory, your program needs to know neither the shapes nor the positions of the objects being animated. A yellow ball, a bowl of petunias or even a surprised-looking sperm whale can be brought to life equally easily!

When you run ANIMATION, you will first see how the screen is built up, layer upon layer, using all sixteen colours available in graphics MODE 2. Logical colours 3 to 8 are used to animate the stars and the flight-path, whereas the lines of longitude of the planets are drawn in colours 9 to 14. The reason for using two groups of 'cycled' colours, instead of one as in the example above, is that the stars and boxes must turn black in order to become invisible. The lines of longitude, on the other hand, must merge into the blue surface of the planets in order to disappear. So two groups of colours are used, the first group cycling between yellow and black, whilst the second group cycles between cyan and dark blue.

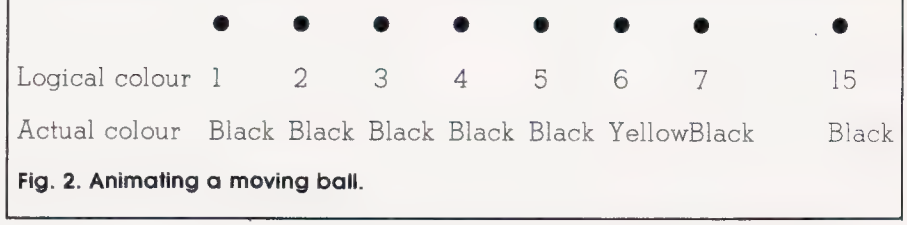
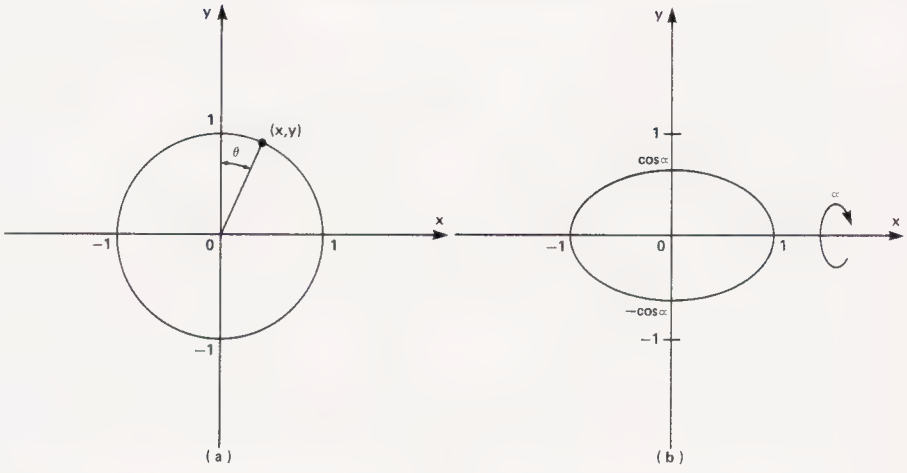


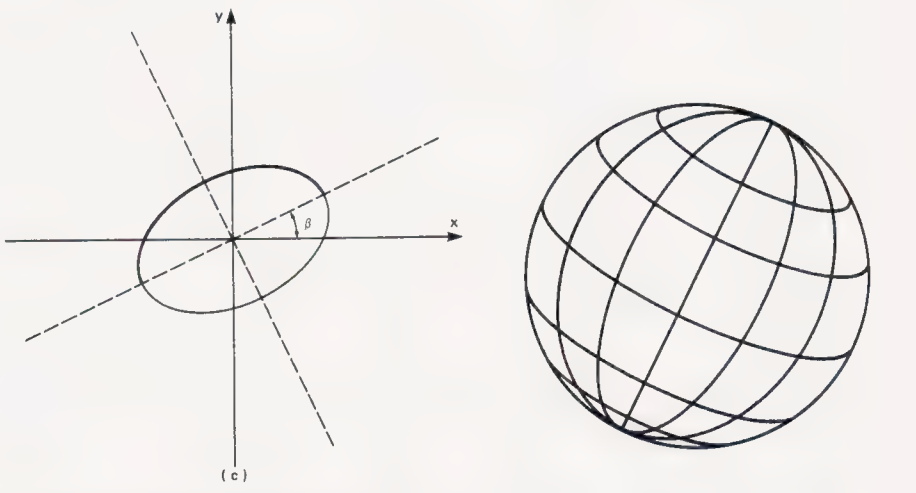
Fig. 2. Animating a moving ball.

Fig. 3: Drawing the planets.



(a) A unit circle viewed head-on from infinity . . .

(b) Then rotated about the x-axis through α radians . . .



(c) Then rotated in the x-y plane through β radians. The thickened section of the curve is a half-ellipse.

(d) Several half-ellipses are combined to produce the image of a planet.

Lines	Effect
100-2010	Select graphics MODE 2 and write titles.
2020-2050	Draw four planets with various positions, sizes and angles of tilt.
2060	Draws the stars and the flight-path.
2070-2090	Define actual colours, ready to commence animation.
3000-3080	Infinite loop which animates display as described earlier.
4000-4160	Definition of the 'sphere' procedure. Set up the graphics necessary to animate a planet, centred on screen co-ordinates (X%,Y%) with a radius R% and angle of axial inclination = tilt radians.
5000-5090	Definition of the 'arc' procedure. Draw part of an ellipse of semi-minor and semi-major axes H% and W% respectively. The ellipse is centred on polar co-ordinates (D%, Alpha) and is orientated so that the minor axis passes through the graphics origin. The elliptic parameter is allowed to vary between −Beta and +Beta.
6000-6080	Definition of the 'path' procedure. Set up graphics for the flight-path.
7000-7070	Definition of the 'square' procedure. Draw a square of side R%, centred on screen co-ordinates (X%,Y%) and rotated through an angle of tilt radians.
8000-8090	Definition of the 'stars' procedure. Set up graphics required to animate the stars.

A LITTLE MATHS

Volumes could be written on the subject of displaying 3-dimensional structures on a 2-dimensional TV screen, but luckily the method which I have used in ANIMATION is the easiest one to explain.

As you read this magazine, your eyes are detecting beams of light travelling in roughly straight lines from all over the page, and the maximum angle between any two such beams is probably about 30 degrees. If you were reading the magazine from a range of 100 yards then this subtended angle would be about 0.3 degrees, and if you had the ultimate in longsightedness and could read this from infinitely far away then the subtended angle would be zero. When drawing distant objects on a computer, it is often easier to pretend that they are infinitely far way, since then all beams of light reaching the observer are parallel. This is the simplification made by ANIMATION when drawing the four planets.

Lines of latitude and longitude on a sphere are circles, and when you view a circle at an angle, from infinity, it looks like an ellipse. We only see half of each of these ellipses, since half of each line of latitude or longitude is on the far side of a planet. Hence, the image of each planet consists of several half-ellipses, as shown in Fig. 3.

CONVERSION NOTES

Owners of micros other than the BBC Micro who wish to convert ANIMATION to run on their machines should first check that their computer:

a) has a 16 colour graphics mode,
b) does not mind if you try to draw shapes which go off screen, and
c) can redefine 'logical to actual colour relationships', as described earlier.

If so, then the following notes will be useful.

MODE 2	160 x 256 graphics in 16 colours, 32 x 20 text. Software regards the screen as 1024 units high by 1280 units wide. Actual colours used by ANIMATION are: 0 black (background) 3 yellow (stars and flight-path) 4 blue (planets) 6 cyan (lines of latitude and longitude) 10 flashing green-magenta (titles)
VDU A,B,C,. . .	Similar to PRINT CHR$(A)+CHR$(B)+ . . (A,B,C, etc, are usually special control codes). If a semicolon follows a number in the VDU list, then it is printed lo-high as a double byte pair. For example:
VDU 5	Used here to make the text cursor vanish.
VDU 18;A	Same as GCOL 0,A
VDU 19,A,B;0;	Logical colour A 'is actual colour B.
VDU 29,X;Y;	Graphics origin has co-ordinates (X,Y) relative to the bottom left-hand corner of the screen.
PROCfred (A,B,. . .)	Calls the procedure called 'fred' and passes the values A,B, etc, to the corresponding local variables listed in the procedural definition.
DEF PROCfred (P,Q, . .)	Start of procedural definition.
ENDPROC	End of procedural definition.
REPEAT . .UNTIL FALSE	An infinite loop.
K9=INKEY(5)	Used here as a 50 millisecond delay.
MOVE X,Y	Moves graphics cursor to co-ordinates (X,Y) relative to the graphics origin
DRAW X,Y	Draws a line to point (X,Y)
PLOT 85,X,Y	Fills in triangle, the vertices being (X,Y) and the last two points visited.
GCOL 0,A	Graphics now in logical colour A.
POINT (X,Y)	Returns the colour of graphics point (X,Y) or −1 if that point lies off the screen

```
LIST
  232REM ***  'ANIMATION'  ***
 1010REM *** STA July 1982 ***
 1020
 2000MODE 2:COLOUR 15
 2010PRINT TAB(6)"ANIMATION":VDU 5
 2020PROCsphere(150,900,100,-PI/6)
 2030PROCsphere(1190,945,75,-5*PI/4)
 2040PROCsphere(620,512,400,7*PI/6)
 2050PROCsphere(200,-292,900,0)
 2060PROCstars:PROCpath
 2070VDU 19,1,6;0;19,2,4;0;19,15,10;0;29,0;0;
 2080FOR I%=9 TO 14:VDU 19,I%,0;0;:NEXT
 2090
 3000REPEAT
 3010FOR I%=3 TO 8
 3020J%=I%-1:IF J%=2 J%=8
 3030VDU 19,J%,4;0;19,I%,6;0;
 3040VDU 19,J%+6,0;0;19,I%+6,3;0;
 3050K9=INKEY(5)
 3060NEXT
 3070UNTIL FALSE
 3080
 4000DEF PROCsphere(X%,Y%,R%,Tilt)
 4010VDU 18;2,29,X%;Y%;:MOVE 0,R%
 4020FOR Phi=0 TO 6.4 STEP .15
 4030MOVE 0,0:PLOT 85,R%*SIN Phi,R%*COS Phi
 4040NEXT
 4050Col%=3
 4060FOR Phi=0 TO 3.1 STEP .1
 4070GCOL 0,Col%
 4080PROCarc(R%*COS Phi,R%,0,PI/2+Tilt,PI/2)
 4090Col%=Col%+1:IF Col%=9 Col%=3
 4100NEXT
 4110GCOL 0,1
 4120FOR Theta=.5 TO 2.5 STEP .5
 4130PROCarc(-R%/4*SIN Theta,R%*SIN Theta,R%*COS Theta,Ti
lt,1.5)
 4140NEXT
 4150ENDPROC
 4160
 5000DEF PROCarc(H%,W%,D%,Alpha,Beta)
 5010S=SIN Alpha:C=COS Alpha
 5020X%=W%*SIN Beta:Y%=D%+H%*COS Beta
 5030MOVE C*X%+S*Y%,C*Y%-S*X%
 5040FOR Gamma=-Beta TO Beta+.1 STEP .25
 5050X%=-W%*SIN Gamma:Y%=D%+H%*COS Gamma
 5060DRAW C*X%+S*Y%,C*Y%-S*X%
 5070NEXT
 5080ENDPROC
 5090
 6000DEF PROCpath
 6010X%=1179:Y%=130:R%=100:Col%=9
 6020FOR Tilt=0 TO 1.2 STEP .05
 6030GCOL 0,Col%:PROCsquare(X%,Y%,R%,Tilt)
 6040X%=.9*X%+80:Y%=.5*Y%+440:R%=R%*.92
 6050Col%=Col%+1:IF Col%=15 Col%=9
 6060NEXT
 6070ENDPROC
 6080
 7000DEF PROCsquare(X%,Y%,R%,Tilt)
 7010VDU 29,X%;Y%;
 7020S=SIN Tilt:C=COS Tilt
 7030MOVE R%*(C+S),R%*(C-S)
 7040DRAW R%*(C-S),R%*(-C-S):DRAW R%*(-C-S),R%*(S-C)
 7050DRAW R%*(S-C),R%*(C+S):DRAW R%*(C+S),R%*(C-S)
 7060ENDPROC
 7070
 8000DEF PROCstars
 8010VDU 29,0;0;
 8020FOR I%=0 TO 40
 8030X%=1279:Y%=25*I%:X1%=-8*(2+RND(2)):Y1%=1-RND(3):Col%
=RND(6)+8
 8040REPEAT Col%=Col%+1:IF Col%=15 Col%=9
 8050P%=POINT(X%,Y%):IF P%=0 GCOL 0,Col%:PLOT 69,X%,Y%
 8060X%=X%+X1%:Y%=Y%+Y1%
 8070UNTIL P%<0
 8080NEXT
 8090ENDPROC
>
```


sinclair
ZX Spectrum
BLUE
EDIT
RED
CAPS LOCK
MAGENTA
TRUE VIDEO
GREEN
INV. VIDEO
CYAN
YELLOW
WHITE
GRAPHICS
BLACK
DELETE
DEF FN
FN
LINE
OPEN #
CLOSE #
MOVE
ERASE
POINT
CAT
FORMAT
SIN
COS
TAN
INT
RND
STR$
CHR$
CODE
PEEK
TAB
ASN
ACS
ATN
VERIFY
MERGE
AND
OR
AT
READ
RESTORE
DATA
SGN
ABS
SQR
VAL
LEN
USR
STOP
NOT
STEP
TO
THEN
CIRCLE
VAL$
SCREEN$
ATTR
LN
EXP
LPRINT
LLIST
BIN
IN KEYS
PI
BEEP
INK
PAPER
FLASH
BRIGHT
OVER
INVERSE
SYMBOL SHIFT

Sinclair ZX Spectr

16K or 48K RAM... full-size moving-key keyboard... colour and sound... high-resolution graphics...

From only £125!

First, there was the world-beating Sinclair ZX80. The first personal computer for under £100.

Then, the ZX81. With up to 16K RAM available, and the ZX Printer. Giving more power and more flexibility. Together, they've sold over 500,000 so far, to make Sinclair world leaders in personal computing. And the ZX81 remains the ideal low-cost introduction to computing.

Now there's the ZX Spectrum! With up to 48K of RAM. A full-size moving-key keyboard. Vivid colour and sound. High-resolution graphics. And a low price that's unrivalled.

Professional power – personal computer price!

The ZX Spectrum incorporates all the proven features of the ZX81. But its new 16K BASIC ROM dramatically increases your computing power.

You have access to a range of 8 colours for foreground, background and border, together with a sound generator and high-resolution graphics.

You have the facility to support separate data files.

You have a choice of storage capacities (governed by the amount of RAM). 16K of RAM (which you can uprate later to 48K of RAM) or a massive 48K of RAM.

Yet the price of the Spectrum 16K is an amazing £125! Even the popular 48K version costs only £175!

You may decide to begin with the 16K version. If so, you can still return it later for an upgrade. The cost? Around £60.

Ready to use today, easy to expand tomorrow

Your ZX Spectrum comes with a mains adaptor and all the necessary leads to connect to most cassette recorders and TVs (colour or black and white).

Employing Sinclair BASIC (now used in over 500,000 computers worldwide) the ZX Spectrum comes complete with two manuals which together represent a detailed course in BASIC programming. Whether you're a beginner or a competent programmer, you'll find them both of immense help. Depending on your computer experience, you'll quickly be moving into the colourful world of ZX Spectrum professional-level computing.

There's no need to stop there. The ZX Printer – available now – is fully compatible with the ZX Spectrum. And later this year there will be Microdrives for massive amounts of extra on-line storage, plus an RS232 / network interface board.

Key features of the Sinclair ZX Spectrum

- Full colour – 8 colours each for foreground, background and border, plus flashing and brightness-intensity control.
- Sound – BEEP command with variable pitch and duration.
- Massive RAM – 16K or 48K.
- Full-size moving-key keyboard – all keys at normal typewriter pitch, with repeat facility on each key.
- High-resolution – 256 dots horizontally x 192 vertically, each individually addressable for true high-resolution graphics.
- ASCII character set – with upper- and lower-case characters.
- Teletext-compatible – user software can generate 40 characters per line or other settings.
- High speed LOAD & SAVE – 16K in 100 seconds via cassette, with VERIFY & MERGE for programs and separate data files.
- Sinclair 16K extended BASIC – incorporating unique 'one-touch' keyword entry, syntax check, and report codes.

um

ZX Spectrum software on cassettes – available now

The first 21 software cassettes are now available directly from Sinclair. Produced by ICL and Psion, subjects include games, education, and business/household management. Galactic Invasion... Flight Simulation... Chess... History... Inventions... VU-CALC... VU-3D 47 programs in all. There's something for everyone, and they all make full use of the Spectrum's colour, sound and graphics capabilities. You'll receive a detailed catalogue with your Spectrum.

RS232/network interface board

This interface, available later this year, will enable you to connect your ZX Spectrum to a whole host of printers, terminals and other computers.

The potential is enormous. And the astonishingly low price of only £20 is possible only because the operating systems are already designed into the ROM.

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Sinclair Research Ltd, Stanhope Road, Camberley, Surrey GU15 3PS.
Tel: Camberley (0276) 685311.

The ZX Printer – available now

Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set – including lower-case characters and high-resolution graphics.

A special feature is COPY which prints out exactly what is on the whole TV screen without the need for further instructions. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.

The ZX Microdrive – coming soon

The new Microdrives, designed especially for the ZX Spectrum, are set to change the face of personal computing.

Each Microdrive is capable of holding up to 100K bytes using a single interchangeable microfloppy.

The transfer rate is 16K bytes per second, with average access time of 3.5 seconds. And you'll be able to connect up to 8 ZX Microdrives to your ZX Spectrum.

All the BASIC commands required for the Microdrives are included on the Spectrum.

A remarkable breakthrough at a remarkable price. The Microdrives are available later this year, for around £50.

How to order your ZX Spectrum

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day. BY FREEPOST – use the no-stamp needed coupon below. You can pay by cheque, postal order, Barclaycard, Access or Trustcard.

EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research, FREEPOST, Camberley, Surrey, GU15 3BR. **Order**

Qty	Item	Code	Item Price £	Total £
	Sinclair ZX Spectrum – 16K RAM version	100	125.00	
	Sinclair ZX Spectrum – 48K RAM version	101	175.00	
	Sinclair ZX Printer	27	59.95	
	Printer paper (pack of 5 rolls)	16	11.95	
	Postage and packing: orders under £100	28	2.95	
	orders over £100	29	4.95	
			Total £	

Please tick if you require a VAT receipt ☐

*I enclose a cheque/postal order payable to Sinclair Research Ltd for £ _____

*Please charge to my Access/Barclaycard/Trustcard account no.

*Please delete/complete as applicable

Signature

PLEASE PRINT

Name: Mr/Mrs/Miss

Address

COT812

FREEPOST – no stamp needed. **Prices apply to UK only.** **Export prices on application.**

Sinclair ZX Spectrum–technical data.

Dimensions

Width	233 mm
Depth	144 mm
Height	30 mm

CPU/ memory

Z80A microprocessor running at 3.5 MHz. 16K-byte ROM containing BASIC interpreter and operating system.

16K-byte RAM (plus optional 32K-byte RAM on internal expansion board) or 48K-byte RAM.

Keyboard

40-moving-key keyboard with full upper and lower case with capitals lock feature. All BASIC words obtained by single keys, plus 16 graphics characters, 22 colour control codes, and 21 user-definable graphics characters. All keys have auto repeat.

Display

Memory-mapped display of 256 pixels x 192 pixels; plus one attributes byte per character square, defining one of eight foreground colours, one of eight background colours, normal or extra brightness and flashing or steady. Screen border colour also settable to one of eight colours. Will drive a PAL UHF colour TV set, or black and white set (which will give a scale of grey), on channel 36.

Sound

Internal loudspeaker can be operated over more than 10 octaves (actually 130 semitones) via basic BEEP command. Jack sockets at the rear of computer allow connections to external amplifier/ speaker.

Graphics

Point, line, circle and arc drawing commands in high-resolution graphics.
16 pre-defined graphics characters plus 21 user-definable graphics characters. Also functions to yield character at a given position, attribute at a given position (colours, brightness and flash) and whether a given pixel is set. Text may be written on the screen on 24 lines of 32 characters. Text and graphics may be freely mixed.

Colours

Foreground and background colours, brightness and flashing are set by BASIC INK, PAPER, BRIGHT and FLASH commands. OVER may also be set, which performs an exclusive–or operation to overwrite any printing or plotting that is already on the screen. INVERSE will give inverse video printing. These six commands may be set globally to cover all further PRINT, PLOT, DRAW or CIRCLE commands, or locally within these commands to cover only the results of that command. They may also be set locally to cover text printed by an INPUT statement. Colour-control codes, which may be accessed from the keyboard, may be inserted into text or program listing, and when displayed will override the globally set colours until another control code is encountered. Brightness and flashing codes may be inserted into program or text, similarly. Colour-control codes in a program listing have no effect on its execution. Border colour is set by a BORDER command. The eight colours available are black, blue, red, magenta, green, cyan, yellow and white. All eight colours may be present on the screen at once, with some areas flashing and others steady, and any area may be highlighted extra bright.

Screen

The screen is divided into two sections. The top section – normally the first 22 lines – displays the program listing or the results of program or command execution. The bottom section – normally the last 2 lines – shows the command or program line currently being entered, or the program line currently being edited. It also shows the report messages. Full editing facilities of cursor left, cursor right, insert and delete (with auto-repeat facility) are available over this line. The bottom section will expand to accept a current line of up to 22 lines.

Mathematical operations and functions

Arithmetic operations of +, –, ×, ÷, and raise to a power. Mathematical functions of sine, cosine, tangent and their inverses; natural logs and exponentials; sign function, absolute value function, and integer function; square root function, random number generator, and pi.

Numbers are stored as five bytes of floating point binary – giving a range of $+3\times10^{-39}$ to $+7\times10^{38}$ accurate to $9\frac{1}{2}$ decimal digits.

Binary numbers may be entered directly with the BIN function. =, >, <, >=, <= and <> may be used to compare string or arithmetic values or variables to yield 0 (false) or 1 (true). Logical operators AND, OR and NOT yield boolean results but will accept 0 (false) and any number (true).

User-definable functions are defined using DEF FN, and called using FN. They may take up to 26 numeric and 26 string arguments, and may yield string or numeric results.

There is a full DATA mechanism, using the commands READ, DATA and RESTORE.

A real-time clock is obtainable.

String operations and functions

Strings can be concatenated with +. String variables or values may be compared with =, >, <, >=, <=, <> to give boolean results. String functions are VAL, VAL$, STR$ and LEN. CHR$ and CODE convert numbers to characters and vice versa, using the ASCII code.

A very powerful string slicing mechanism exists, using the form a$ (x TO y).

Variable names

Numeric – any string starting with a letter (upper and lower case are not distinguished between, and spaces are ignored).
String – A$ to Z$.
FOR-NEXT loops – A-Z.
Numeric arrays – A-Z.
String arrays – A$ to Z$.

Simple variables and arrays with the same name are allowed and distinguished between.

Arrays

Arrays may be multi-dimensional, with subscripts starting at 1. String arrays, technically character arrays, may have their last subscript omitted, yielding a string.

Expression evaluator

A full expression evaluator is called during program execution whenever an expression, constant or variable is encountered. This allows the use of expressions as arguments to GOTO, GOSUB, etc.

It also operates on commands allowing the ZX Spectrum to operate as a calculator.

Cassette interface

The ZX Spectrum incorporates an advanced cassette interface. A tone leader is recorded before the information to overcome the automatic recording level fluctuations of some tape recorders, and a Schmitt trigger is used to remove noise on playback.

All saved information is started with a header containing information as to its type, title, length and address information. Program, screens, blocks of memory, string and character arrays may all be saved separately.

Programs, blocks of memory and arrays may be verified after saving to confirm successful saving.

Programs and arrays may be merged from tape to combine them with the existing contents of memory. Where two line numbers or variables names coincide, the old one is overwritten.

Programs may be saved with a line number, where execution will start immediately on loading.

The cassette interface runs at 1500 baud, through two 3.5 mm jack plugs.

Expansion port

This has the full data, address and control busses from the Z80A, and is used to interface to the ZX Printer, the RS232 and NET interfaces and the ZX Microdrives.

IN and OUT commands give the I/O port equivalents of PEEK and POKE.

ZX81 compatibility

ZX81 BASIC is essentially a subset of ZX Spectrum BASIC. The differences are as follows.

FAST and SLOW: the ZX Spectrum operates at the speed of the ZX81 in FAST mode with the steady display of SLOW mode, and does not include these commands.

SCROLL: the ZX Spectrum scrolls automatically, asking the operator "scroll?" every time a screen is filled.

UNPLOT: the ZX Spectrum can unplot a pixel using PLOT OVER, and thus achieves unplot.

Character set: the ZX Spectrum uses the ASCII character set, as opposed to the ZX81 non-standard set.

ZX81 programs may be typed into the ZX Spectrum with very little change, but may of course now be considerably improved. The ZX Spectrum is fully compatible with the ZX Printer, which can now print out a full upper and lower case character set, and the high resolution graphics; using LLIST, LPRINT and COPY.
ZX81 software cassettes and the ZX 16K RAM pack will not operate with the ZX Spectrum.

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ZX Spectrum

Sinclair Research Ltd, Stanhope Road, Camberley, Surrey, GU15 3PS. Tel: Camberley (0276) 685311.

Mike James

Designed by the man who brought you the PET, this professional system both looks and feels good. However,as our reviewer finds out, all may not yet be roses.

The ACT Sirius 1 is a machine which deserves a good hard look and a detailed appraisal, if only because it is the latest offering from Chuck Peddle. Who is Chuck Peddle, I hear you ask? There are only a few people who could claim to have been in at the initial development of the personal computer and still be actively contributing new ideas or new machines and Chuck Peddle is probably the most famous of them all.

Firstly, he is credited with the design of the 6502 microprocessor for MOS Technology. (The idea of a single person designing a microprocessor is something I find difficult to believe — and the 6502 is even more of a committee job than most!) Secondly, and more credibly, he is regarded as the driving force behind the revolutionary Commodore PET (which used the 6502 and so many other MOS Technology chips that Commodore eventually decided to buy the firm!)

AN OVERVIEW

The box which the Sirius arrived in was large enough to contain a small dish washer or refrigerator — the contents are well-packaged for transit.

The first thing you find is a large chart showing how to remove and assemble the three main parts of the machine. As each part — the keyboard, the CPU and the monitor — was unpacked, I felt a sense of growing excitement and enthusiasm that I thought I had grown out of after doing so many reviews. The feeling of quality and 'rightness' was something that made itself clear even before I had assembled the components. Even without following the huge instruction sheet, it seemed as though the Sirius would assemble itself!

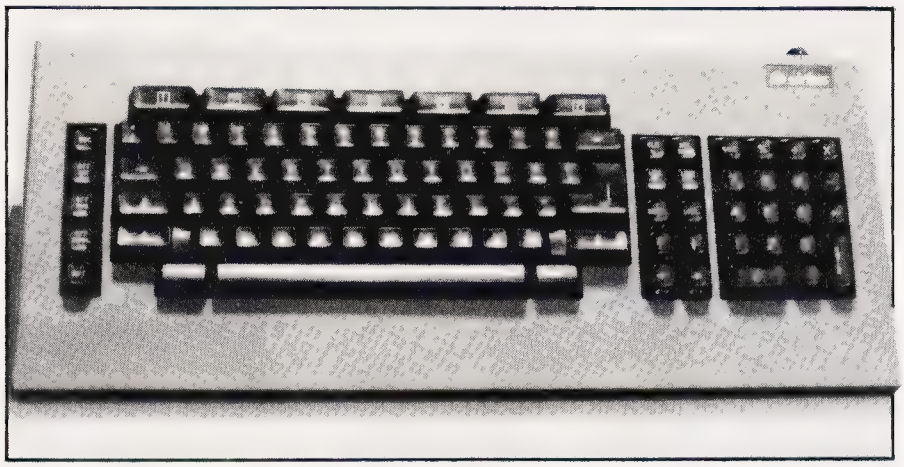
The basic shape introduced by the PET — a lower unit with the keyboard and the monitor mounted on top — is difficult to beat and the Sirius adopts this basic form (with the noticeable difference that the three components are all separate units) and then adapts it to the needs of today's 'minimum' system. In other words, everything is made a little larger to allow two 5¼" disc drives to be mounted horizontally in the base unit.

My initial feelings about the Sirius seem to be exactly what they should be, given that Chuck Peddle describes his new machine as a 'third generation micro' (by which he means that the first generation was composed of machines such as the PET and Apple). The second generation is composed of machines which are full implementations of eight-bit micro systems — ie 64K twin disc Z80/8080 machines such as the SuperBrain or the Tandy Model III. The third generation (according to Chuck Peddle at least) is heralded by the Sirius and is distinguished not so much by its technology but more by its overall design — here the word 'ergonomic' rears its ugly head. Third generation micros are supposed to be designed so that they are not only good to look at, but easy to use. This is where it becomes difficult to agree on an objective assessment on what is 'easy to use'. The Sirius is supposed to be the first machine to be aimed at the user rather than the programmer. Such a claim can only be tested by looking at both the software as well as the hardware — but the software doesn't stand a chance unless the hardware comes up to scratch.

THE KEYS TO SUCCESS

There are two things that immediately impress any user — the quality of the keyboard and the monitor. As already mentioned, the keyboard is a separate unit and although it is remarkably thin, it has added weight to keep it in one place while you type on it. The individual keys are laid out in raised 'tiers' and are angled to make typing easier. In addition to the usual QWERTY keys, there are also two separate 'control' keypads, a numeric keypad and seven programmable 'soft' keys. The Sirius' keyboard is one of the best I have used and apart from one or two small 'quirks', such as the control key being marked 'ALT', it should meet anyone's requirements.

The monitor which comes with ▶



The keyboard supplied with the ACT Sirius 1 must rate as one of the nicest to date.

the Sirius sits on top of the main box on a very simple turn and tilt mechanism. This, coupled with a very effective non-glare coating and very high resolution, once again gives an overall impression of quality. The ability to alter the angle and orientation of the monitor screen is very pleasing but wouldn't be quite so necessary if the anti-reflection coating didn't also reduce the angle that the screen was usable at to something like 20 degrees. This isn't meant as a criticism, I just wish to point out that sometimes it is necessary to think through the effect of every design feature.

My only real criticism of what is otherwise a very acceptable monitor, is the persistence of the phosphor. It is noticeable that all of the demo software works in 'page' mode. As soon as you list a program and the screen starts to scroll at any speed, the result is not only difficult to read but it's enough to make you feel ill. There are plans to replace the green phosphor monitor with a high resolution yellow phosphor one — I only hope it has a lower persistence.

Apart from this slight problem, the monitor and the Sirius' overall display capacity is exceptional. Both brightness and contrast can be controlled from the keyboard or by software, as can the volume of the built-in speaker.

Although colour isn't a feature of the Sirius, it is capable of hi-resolution graphics (800 x 400) and a remarkable range of character styles. As there is only a single display mode, and graphics and characters are produced by the same hardware, there is no problem in freely mixing text and graphics to produce labelled graphs and the like. The 'standard' screen is composed of 25 lines of 80 characters but this can easily be changed to 50 lines of 132 characters if anyone wants to display this much information in one go.

Although the text display format has been designed to handle the almost industry standard 25 line by 80 characters, and so really cannot be faulted, it is a little sad that the Sirius didn't lead the way with an A4 sized screen — after all, this is obviously the way user-oriented machines will go. The characters are all formed from a 10 by 16 dot matrix. As character set definitions are all held in RAM (up to a maximum of 2048 at any one time) there is no shortage of special characters — Greek, mathematical, etc — and any which are missing can easily be defined! The Sirius can hardly boast 'user-defined characters available' when the whole character set is user-definable!

GETTING STARTED

For the first time user, the Sirius is fairly easy to get started. When it is first switched on, the Sirius displays a small but detailed picture of a 5¼" floppy disc as a request for the user to feed it. This is a nice touch, but on balance I think I personally would rather have a printed message saying 'Insert disc into left-hand drive'. But I suppose it all adds to the image. Once you have managed to find and place an operating system disc in the correct drive and closed the door, the Sirius behaves just like any other CP/M based system. This aspect is discussed further in the section on software, but I am sad to say that this is where things start to go wrong.

There are a number of hardware features which are important from a user's point of view that are normally left to the hardware section. The first is that the Sirius isn't a run of the mill (no pun intended!) Z80 or 8080 machine. neither does it use the trusty 6502 which has brought such wealth to Commodore. Surely a 'third generation' micro such as the Sirius is going to impress us with a super 16-bit micro such as the 68000 or the 8086? No, the chip which drives the Sirius is the 'half way house' 8088. The 8088 is internally a 16-bit processor but externally it behaves like an eight-bit micro. The big selling point of the 8088 is that it is compatible with the 8086 — Intel's full 16-bit processor. This means that any software written for the 8086 will run on the Sirius. Maybe not as fast but it will run!

Another consequence of using the 8088 instead of a traditional eight-bit chip is the large amount of memory that the Sirius can handle. It comes with 128K as standard (typically twice as much memory as you would find on comparable micros) and this can be expanded to 1M — (yes, one megabyte!). What an innocent user is going to do with so much memory is difficult to see with the range of software that is around at the moment, but I am sure this will change.

A SERIOUS MICRO?

To finish this overview on a high note, it is worth mentioning the serious subject of disc capacity and the more frivolous subject of speech synthesis. The Sirius' built-in twin 5¼" drives can store an enormous 600K using only one side. This is as much as an 8" disc can handle on two sides, let alone one. The way this amount of storage has been achieved is discussed in the section on hardware, but what is important to the user is that (as far as I have been able to discover in the review period) it is reliable and the access time is not noticeably higher than other systems.

The Sirius' only concession to the latest crop of colourful noisy machines is that it has a speech synthesiser. Typically, however, this isn't something which has been included for fun as is evident by the fact that it is impossible to program it to speak unless you have some extra hardware and there are no programmed words or phrases for the casual BASIC programmer to have fun with. The idea is that software houses will produce applications packages which will hold friendly conversations with computer-naive users.

OPENING THE BOX

I must admit that I approached the Sirius, screw driver at the ready, with some apprehension. Taking such a machine apart is like graduating from operating on small mammals to thoroughbred race horses!

I needn't have worried because getting inside was very easy indeed, a service engineer's dream. Once

there, I found that the Sirius was indeed mortal — the usual collection of chips and printed circuit boards — but the impression of quality remained. The electronics is presented as two PCBs, the smaller being mounted toward the top of the box and across the twin disc drive chassis and containing the disc interface; the larger (15" by 12") holds everything else. The power supply is mounted in a metal case to the rear of the case (conveniently near a small cooling fan). This is evidently a switched mode design because there isn't a large transformer in sight. It runs cool, with low radio interference (the curse of switched mode designs).

The main PCB is well made and there are no signs of any last minute modifications. (Indeed there are no signs of any modifications anywhere!) A quick survey of the components used immediately shows that although the Sirius has an Intel brain (the 8088 CPU) a lot of the other devices belong to the 6500 and 6800 family. There are three 6522 PIA chips doing unspecified things by the fan (probably looking after the Centronics printer and IEEE 488 interfaces) and a 6845 video controller looking after the screen.

The 8088 chip is the only chip, apart from a pair of EPROMs, thought worthy of a socket. A point worth noticing is that it is teamed up with an Intel 8259 programmable interrupt controller so here, once again, is scope for the inventive systems programmer. The 128K of memory is provided by two rows of eight 64K-bit 4164 chips from Texas. There is no room to mount extra memory on the main board and expansion is achieved by the use of four interface slots and extra PCBs. The initial system programs are contained in a pair of 2732 EPROMs giving a total of 8K bytes. What there is stored in 8K bytes of EPROM is difficult to say but the Sirius certainly doesn't give any hint to the casual user of having so much non-disc based software.

Apart from the main memory bank, there are two 6116 16K static RAM chips placed close to the video controller chip. The 6116 is a peculiar RAM chip in that it is organised as 2K by 8 bits. This extra 4K bytes of static RAM is almost certainly used to hold the dot patterns for the character set. Whatever it is used for, the Sirius could definitely be described as a 132K machine!

Other large chips that can be found on the main board are — a 6852 synchronous serial adaptor, an 8253 programmable interrupt timer and a D7201 disc controller chip. Apart from the mixing of Intel and 6800 chips there isn't anything revolutionary about the Sirius's hardware. It is a fairly straightforward single processor RAM, ROM, bit-mapped video design. It is not exciting but neither is it disappointing — there are a lot of interesting devices used.

Before moving onto the details of the disc unit it is worth mentioning the fact that there is a full range of interfaces brought out of the back of the main board. Working from left to right we have a Centronics parallel interface which doubles as an IEEE 488 interface, a standard RS232 serial interface and a synchronous serial port for high speed communications with other computers. Also on the back panel, along with the interface connectors, are the on-off switch, power connector, keyboard connector, monitor connector and a reset switch.

WHAT'S IN STORE?

The Sirius' disc drives are very special. The hardware is standard but the electronics were specially made for the Sirius.

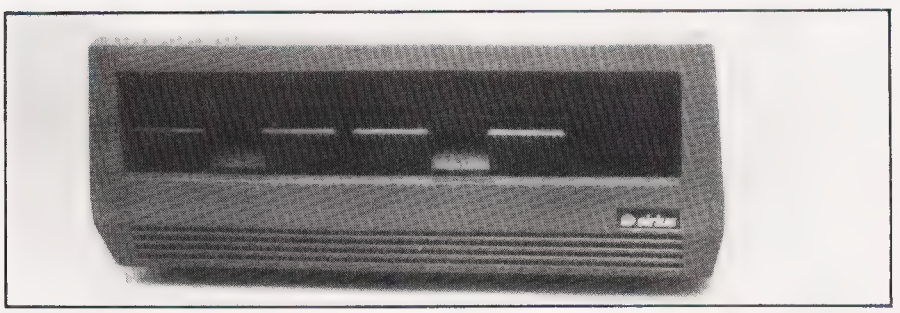
In fact, the huge storage capacity of the Sirius' drives is achieved by the use of a technique very similar to the way the Commodore drives work. Using a microprocessor (Intel 8748) with its own 2K of EPROM a variable number of sectors are squeezed into each track. This is possible because the number of sectors you can write onto the surface of a disc depends on the speed that the surface passes under the read/write head; obviously this is fast at the outer edge and gets slower as the head moves towards the middle. Also , the length of each track varies as the head moves toward the middle. Most disc controllers aren't clever enough to make use of this fact and write the same number of sectors on outer tracks as on the inner tracks. However, the Sirius uses a microprocessor and this is easily clever enough to cope with a variable number of sectors per track.

This isn't the end of the story, however, because not only does it alter the number of sectors per track, it alters the disc's speed of rotation as the head moves toward the centre. You can hear the whine of the disc drive motor increasing as the head moves in to the centre of the disc. The speed varies from 250rpm to 350rpm (normal disc speed is 300rpm) and this allows 19 sectors to the packed onto the outer track reducing to 12 on the inner track.

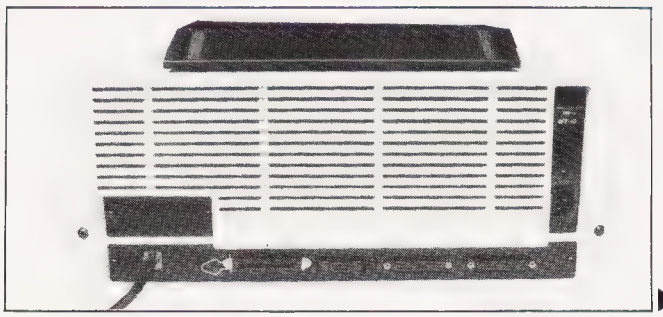
Using this ingenious method the total storage capacity of a 5¼" inch disc is increased to 600K (remember a single-sided single-density disc will hold 80K) on one side. There is no reason why this shouldn't be extended to double-sided discs and there are indeed plans to do so. This will give the Sirius a total disc capacity of 2.2M on 5¼" discs! There is, of course, one big penalty to be paid for this improved capacity — compatibility. The Sirius' discs are hardware incompatible with just about everything else.

SOFTWARE

The Sirius is a user's machine and, apart from a few small ergonomic features of the hardware, this is achieved through its software. The first program the user will meet is the operating system and there are two available for the Sirius — CP/M-86 from Digital Research and MS-DOS from Microsoft. CP/M-86 is a version of CP/M for the Intel 8086



The front of the main unit revealing the 1.2M drives.



The rear of the unit is generously supplied with sockets.

and hence can run on the 8088 inside the Sirius. This is a pity because if CP/M wasn't available for the Sirius no one would feel the need to invent it.

Originally CP/M was a reasonable way of hanging disc drives onto a wide range of Z80/8080 based hardware. It was a first attempt at a software driver to make life easy for the systems programmer — it is difficult to even think of it as an operating system. For a reason that I have never been able to understand, CP/M caught on and has now become a byword in compatibility.

With the introduction of CP/M-86 Digital Research had a second chance to get CP/M right — they didn't. On reflection, their track record for improvement is very poor — the CP/M manual didn't improve as each version of CP/M was issued; in fact, because of all the amendments, it got worse! From a user's point of view, CP/M-86 is a disaster area — it has poor error handling, even worse error messages, poor control of I/O, and it is sensitive to user errors (eg if you route output to a printer that isn't there, the system hangs with the resulting loss of everything that you haven't saved on disc). A complete critique of CP/M and CP/M-86 would fill another ten pages and would take us into some difficult areas but the most important point is that if you have never seen anything better, you might believe that CP/M's way of doing things is the only way — if you have seen anything better then you won't need me to tell you what's missing from CP/M or CP/M-86.

FACTSHEET	Sirius 1	
CPU	8088	
Clock	5MHz	
ROM	8K	
RAM	128K 4K character RAM	
Language	BASIC-86	
Keyboard	Full QWERTY with numeric and control pads and extra control keys. Detatchable.	
Display	800 by 400 points, bit-mapped display Monitor is at present, green phosphor — to be replaced by yellow phosphor Text — 25 by 80	
Disc	Twin 600K 5¼" discs (1.2M total)	
Cassette	None	
I/O	RS232 Centronics IEEE 488 Sychronous serial	
Options	Extra RAM in 128K steps Languages and system software 5M and 10M Winchester discs	
Costs	Sirius 1 plus 128K	£2,395 plus VAT
	128K RAM	£500
Supplier	ACT (Sirius) Ltd Shenstone House Dudley Road Halesowen West Midlands B63 3NT	

IT'S GETTING BETTER

Talking of better things brings us to MS-DOS from Microsoft. MS-DOS isn't compatible with CP/M, although there is a program included which will transfer a CP/M disc to MS-DOS. As Microsoft produce the interpreters and compilers for most micros, you would think that they at least would have no trouble with rethinking an operating system and then interfacing it to their range of products. They are in such a strong position that you could almost say that where Microsoft goes, the rest are sure to follow. Unfortunately, I am very reluctant to follow Microsoft down the MS-DOS road!

The trouble is that, although MS-DOS is a completely new product, it performs more like a reengineered version of CP/M. It's the product that you might have expected Digital Research to produce as a second attempt at CP/M. MS-DOS ***is*** better but it is hardly stunning! Error handling and messages are superior, the overall system is more stable under MS-DOS than CP/M 86 but it is still not the software product that the Sirius deserves.

The BASIC that comes with the Sirius is also from Microsoft — BASIC-86. This is a standard, compatible implementation of the BASIC we have all come to know (and love?). The only thing missing is any simple way of controlling the Hi-Res graphics screen. In the demonstration BASIC programs this is done by additional machine code subroutines that are called, but there is no documentation supplied to tell a programmer how to use them.

DOCUMENTATION

The documentation which came with the Sirius was very clearly written and obviously aimed at the non-expert. Instructions spelt out in laudable detail in both the **Introduction to the SIRIUS 1 Computer** and the two guides to CP/M-86 and MS-DOS. What is lacking in this documentation, however, is advanced or technical information which would help expert users to achieve really clever things with their sophisticated machines.

CONCLUSION

The Sirius 1 is definitely a good machine for the business user. It is an attractive, up-to-the-minute design which would grace any office and it has the features that stand it in good stead to move into the future. It is also reasonably priced for an advanced machine. However, my final word has to be — nice machine, shame about the operating systems.

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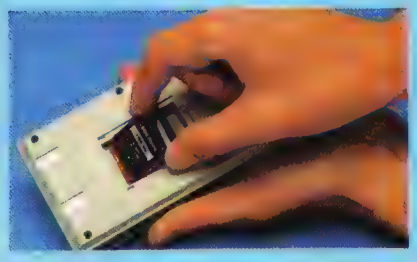

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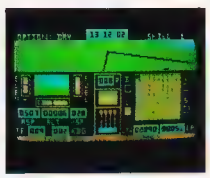


Jumbo Jet Pilot. 16 K ROM Cartridge. 5 skill levels. Performance rating. Controls: Throttle. Ailerons. Elevators Undercarriage. Brakes. Stall Indicator. Lights. Fuel. Longitude. Latitude. Air Speed. Artificial Horizon. Altitude. Pitch and Roll. Heading. Vertical Speed. Map Reference and Grid Time Elapsed

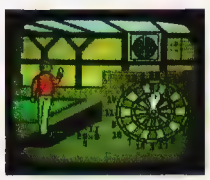
To cope you need to be alert. You should expect the unexpected. And you definitely shouldn't lower the undercarriage when your air speed is dropping and the horizon suddenly appears vertical!

On landing, your in-flight computer will assess your skills and give a 'performance rating'. If you manage to land that is.

'Jumbo Jet Pilot' is one of 21 challenging new home computer games from THORN EMI. It's pretty demanding. But our programs aren't all work and no play.

'River Rescue', 'Kickback', and 'Soccer', are all-action games. 'Pool' and 'Darts' will suit armchair sportsmen.

And whilst budding Beetnovens play the 'VIC Music Composer,' would-be Chancellors can work on their budgets with 'Home Financial Management'.



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Daniel Bishop

GAME TIMES

A multiplication tutor for the ZX81.

So many educational micro—computer programs seem to be either simulations of the real world or quizzes and are often quite boring for a child. But, why should educational programs be boring? If one makes them fun, surely then a child will enjoy the program and learn at the same time.

There do not seem, however, to be many such fun/educational programs for the Sinclair ZX81 with 1K of RAM. The limited memory available is undoubtedly a major reason but, if a little ingenuity is applied when writing the program, then even 1K can be put to use.

THE GAME STRUCTURE

The program I have written, with these thoughts in mind, is called The Multiplication Game. It combines the old chestnut of learning the multiplication table with a theme that is immensely popular with children these days — Space Invader games.

First, the program prints the numbers, 9 to 1 down the left—hand side of the screen and 1 to 9 across the middle of the screen. This is the nine by nine multiplication table, without its entries. At a random position within the table, a strange black blob with white X's on it appears representing the alien spaceship. A prompt then appears at the bottom of the screen. The program waits for a number input. The idea is to look at the position of the alien, multiply its co-ordinates together and input the product. For example, if the alien was above a 3 and alongside a 9 then the correct input would be 27. If the input is correct the alien explodes and the score, which is displayed in the top right—hand corner of the screen, is incremented by one. If the input is incorrect then the alien moves down the table by one position. Also, a variable called S within the program is decremented. The variable S starts off at a value of 72 and is decremented by a value related to the easiness of the multiplication that the child got wrong. The easier the multiplication — the higher the penalty. When S reaches a value of zero then the game ends and a relevant message is desplayed on the screen.

There is a pause so that the child can make a mental note of the score — the number of aliens destroyed — before the game starts again. Whenever an alien is destroyed or reaches the last row in the table, another one appears at a random position and starts moving downwards. The aim of the game is to destroy as many aliens as possible before the game ends. The result of the game is that the child soon learns his or her multiplication table!

HOW IT RUNS

Lines 10 and 20 initialize the variables S and D (D is the number of aliens destroyed) using VAL simply because they are stored more economically in memory that way. Lines 30 and 40 clear the screen and set up a seed for the random number generator. The loop from line 50 to 70 is controlled by Y and loops nine times; It prints the numbers 1 to 9 on the axes of the table. Line 80 makes X an even random number between 2 and 18 inclusive where X is the horizontal position of the alien. It is made an even number because the X—axis of the table is twice the scale of they Y—axis. The loop from line 90 is also controlled by Y and starts at a random value between 0 and 7 inclusive, and ends when Y equals 8 where Y is the vertical position of the alien as measured in lines from the top of the screen.

Line 100 prints the alien at the correct location in the table. The alien consists of two inverse X's (code 189 in the ZX character set). The current score of aliens destroyed, D, is printed in the top right—hand corner of the screen. Line 110 gets the child to input his or her attempt at the multiplication, and assigns it to the variable A. Line 120 compares A with the correct answer for the multiplication; if they are the same then program execution branches to line 210. If not, then the child's answer was incorrect and S is decremented in line 130. Line 140 checks the value of S — if it is less than or equal to zero then the game is over and program execution branches to line 180. Line 150 blanks out the alien with two spaces, in preparation for the alien to be printed at the next location.

Line 160 sends program execution to line 230 if the alien has reached the last row in the table. Line 180 is reached via line 140 when S is less than or equal to zero. It then prints the fact that the game is over. Line 190 pauses program execution. (The PAUSE command of Sinclair's BASIC is equivalent to a FOR...NEXT loop, and is used to create a delay.) Line 200 RUNs the program again. Line 210 is reached via line 120 when the child has got the multiplication correct. It prints two asterisks at the location of the alien. This represents the alien's demise! When typing the asterisks, type a Shifted H to produce them instead of typing a Shifted B twice as this saves all too valuable memory.

Line 220 increments D by one. Line 230 pauses program execution for a moment so that the explosion effect can be seen before it is blanked out in line 240. Line 250 sends program execution back to line 80.

A variation on this program is to change the multiplication sign in line 120 to a plus or a minus sign. The program then teaches simple addition or subtraction. If you wish to change it to a division sign (a slash) then do so by all means — but that is not a game for kids. For example, without a calculator, what is 9 divided by 7?

Program Listing

```
 10  LET S=VAL "72"
 20  LET D=VAL "0"
 30  CLS
 40  RAND
 50  FOR Y=1 TO 9
 60  PRINT AT Y-1,0;10-Y;AT 9,(2*Y);Y
 70  NEXT Y
 80  LET X=(INT(RND*9)*2)+2
 90  FOR Y=INT(RND*7) TO 8
100  PRINT AT X,Y;"[REV]XX[OFF]";
     AT 0,22;"SCORE=";D
110  INPUT A
120  IF A=(X/2)*(9-Y) THEN GOTO 210
130  LET S=S-Y
140  IF S<=0 THEN GOTO 180
150  PRINT AT Y,X;"[2 SPC]"
160  IF Y=8 THEN GOTO 230
170  NEXT Y
180  PRINT AT 2,21;"GAME OVER"
190  PAUSE 500
200  RUN
210  PRINT AT Y,X;"**"
220  LET D=D+1
230  PAUSE 50
240  PRINT AT Y,X;"[2 SPC]"
250  GOTO 80
```

Don't let its size fool you.

If anything NewBrain is like the Tardis.

It may look small on the outside, but inside there's an awful lot going on.

It's got the kind of features you'd expect from one of the really big business micros, but at a price of £269.95 including VAT it won't give you any sleepless nights.

However, let the facts speak for themselves.

You get what you don't pay for.

NewBrain comes with 24K ROM and 32K RAM, most competitors expect you to make do with 16K RAM.

What's more you can expand all the way up to 2 Mbytes, a figure that wouldn't look out of place on a machine costing ten times as much.

We've also given you the choice of 256, 320, 512 and 640 x 250 screen resolution, whereas most only offer a maximum of 256 x 192.

Big enough for your business.

Although NewBrain is as easy as ABC to use (and child's-play to learn to use) this doesn't mean it's a toy.

Far from it.

It comes with ENHANCED ANSI BASIC, which should give you plenty to get your teeth into.

And it'll also take CP/M® so it speaks the same language as all the big business micros, and feels perfectly at home with their software.

NO OTHER MICRO HAS THIS MUCH POWER IN THIS MUCH SIZE FOR THIS MUCH MONEY.

So as a business machine it really comes into its own.

The video allows 40 or 80 characters per line with 25 or 30 lines per page, giving a very professional 2000 or 2400 characters display in all on TV and/or monitor. And the keyboard is full-sized so even if you're all fingers and thumbs you'll still be able to get to grips with NewBrain's excellent editing capabilities.

When it comes to business graphics, things couldn't be easier. With software capabilities that can handle graphs, charts and computer drawings you'll soon be up to things that used to be strictly for the big league.

Answers a growing need.

Although NewBrain, with its optional onboard display, is a truly portable micro, that doesn't stop it becoming the basis of a very powerful system.

The Store Expansion Modules come in packages containing 64K, 128K, 256K or 512K of RAM. So, hook up four of the 512K modules to your machine and you've got 2 Mbytes to play with. Another feature that'll come as a surprise are the two onboard V24 interfaces.

With the aid of the multiple V24 module this allows you to run up to 32 machines at once, all on the same peripherals, saving you a fortune on extras.

The range of peripherals on offer include dot matrix and daisy wheel printers, 9", 12" and 24" monitors plus 5¼" floppy disk drives (100 Kbytes and 1 Mbyte) and 5¼" Winchester drive (6-18 Mbytes).

As we said, this isn't a toy.

It doesn't stop here.

Here are a couple of extras that deserve a special mention.

The first, the Battery Module, means you won't be tied to a 13 amp socket. And, even more importantly, it means you don't have to worry about mains fluctuations wreaking havoc with your programs.

The ROM buffer module gives you a freedom of another sort.

Freedom to expand in a big way. It gives you additional ROM slots, for system software upgrades such as the Z80 Assembler and COMAL, 2 additional V24 ports, analogue ports and parallel ports.

From now on the sky's the limit.

Software that's hard to beat.

A lot of features you'd expect to find on software are actually built into NewBrain so you don't need to worry about screen editing, maths, BASIC and graphics.

However, if you're feeling practical you can always tackle household management, statistics and educational packages. And because NewBrain isn't all work and no play, there's the usual range of mind-bending games to while away spare time.

Waste no more time.

To get hold of NewBrain you need go no further than the coupon at the bottom of the page.

With your order we'll include a hefty instruction manual so you'll know where to start, and a list of peripherals, expansion modules, and software so you'll know where to go next.

® CP/M is the registered trade mark of Digital Research Inc

Technical Specifications

The NewBrain is a fully specified professional computer built to the highest standards of engineering and reliability. Chosen by leading OEM suppliers. Designed to facilitate easy expansion for use with the CP/M operating system, and the addition of 5¼ flexible and Winchester disks, 12 green phosphor professional standard monitor, 80 cps professional quality dot matrix printer with pin addressable graphics.

Z80A cpu and COP 420M input/output microprocessors. 32K RAM expandable to 2 Mbytes. 29K ROM. Dual Cassette Ports. UHF TV port. CCITT Monitor Port Video 40/80 Character x 25/30 lines. 256, 320, 512, 640 x 250 Pixels. Expansion Port. V24 Bi-directional Port. V24 Printer Port. 16-character display (AD only).

Software: Enhanced BASIC (ANSI x 3.2/78) Independent Operating System (12 device drivers). Multi Page Screen Editor (32 Control Commands). Maths (10 Signficant Figures). Graphics (Absolute & Relative Plotting, Line & Arc Drawing, Shading, 20 English Language Commands).

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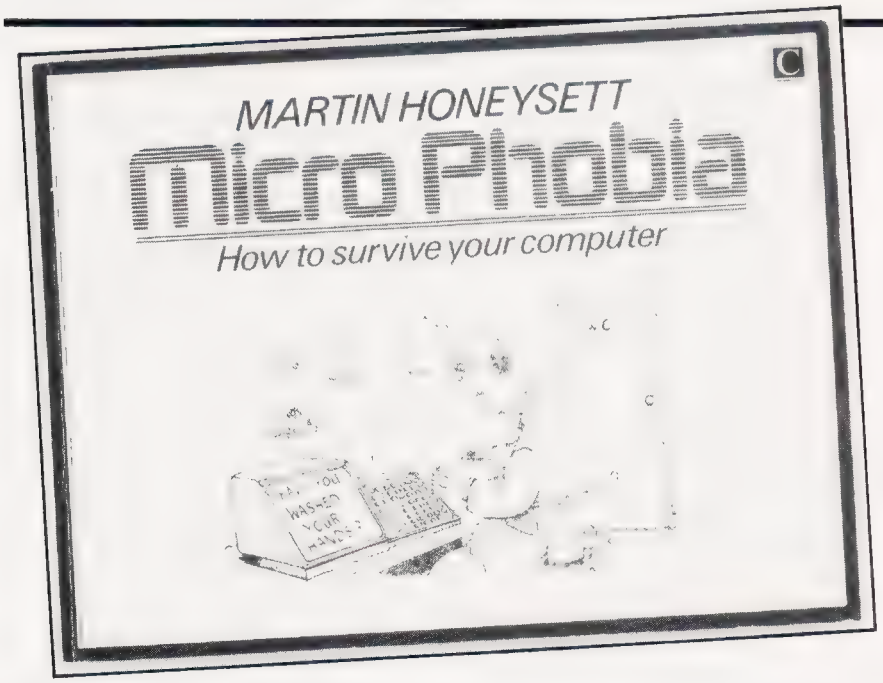
S M Gee

BOOK PAGE

Why not give your computer-mad relative a book this Christmas, or perhaps there's one you would like someone to give you?



The only thing that the books reviewed this month have in common is that they would all make good Christmas presents. So, if you haven't already finished your Christmas shopping (or if it's not too late to drop hints about what you yourself would like as a present) read on.

My first suggestion is a beautifully presented book on a facinating topic. Its title is **Contact: Human Communication and its History** and it takes the form of a series of essays contributed by experts on the subjects of language, non-verbal communication, signs and symbols, alphabets and writing, printing, extended speech and sounds, extended images, communication technologies and social institutions, and the future of the media. The collection is edited by Raymond Williams whose introduction whets the appetite for the rest of the book.

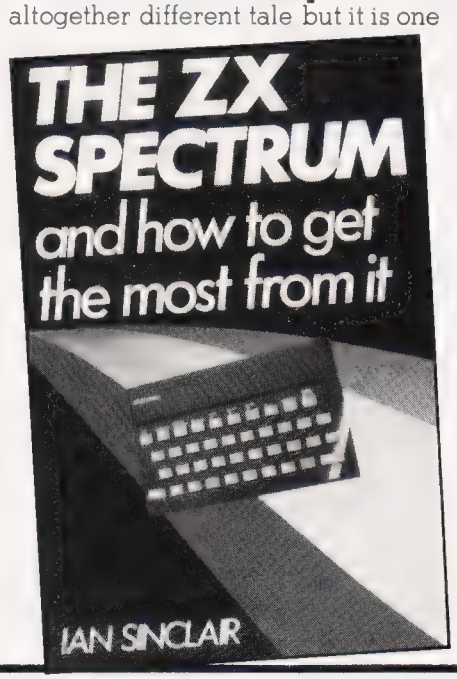
The first thing that strikes you about this book, however, are its illustrations. There are five sections of plates gathering together both colour and black and white photographs on glossy paper; the rest of the book is also well-endowed with black and white photographs and line drawings (according to the dust jacket there are actually 379 illustrations, 57 being in colour). As for the text, I found plenty to hold my interest and attention. The only chapter that I was at all disappointed with was the last one dealing with the future of the media, where I would like to have seen some discussion of the advent of computer communication systems. (The computer gets pretty short shrift in this book but that's actually quite a refreshing change in some ways!) All in all this is a lavish book that would be a pleasure to own.

Micro Man is another book that is enhanced by its illustrations, but in this case, the pictures are definitely secondary to the text. It introduces itself as a book about the developing relationship betweeen human beings and computers, maintaining that "humans have shaped computers, and now computers are shaping us and our environment". The thesis of this book is that computers "are a species in their own right, not yet independant from us, but not necessarily subservient to us either". The subject matter of this book is, therefore, controversial but as we are presented with one man's personal experience, the controversy tends to be masked. I found this book rather disjointed and even a little self-indulgent but, with the caveat that it can be read remembering that there are other viewpoints, **Micro Man** is an interesting and challenging account.

I had a problem with the next book on my list, **The Soul of a New Machine.** The problem was simply keeping it to myself long enough to review it! It certainly rated as the most popular book to reach this reviewer's desk in a long time. To anyone with an interest in computer hardware, this is a book that's hard to put down. It tells the fascinating true story of the birth of a new 32-bit 'supermini' — Data General's Eagle Project. It's a story of wheeler-dealing and intrigue laced with just the right dash of minute detail. It's also a book about personalities as well as technicalities, and is written in a racy style so that the tension is maintained to the last. Giving the world of computer engineering this sort of treatment is a new departure and one that is likely to be entirely welcomed by anybody who has ever been involved with, at whatever level, the world of computer hardware.

Although it's true that the more you know about this world with its idiosyncratic lifestyles the more you'll appreciate the book, it also provides some fascinating insights to anybody with an interest in people and what makes them tick. What drives anybody to become a midnight programmer or to enjoy the challenge of the near-impossible, is something that you can normally only understand if you experience it. Tracy Kidder gives the rest of us a unique chance to share that experience. This book should be prescribed reading for anyone wishing to make a career out of building computers! Above all, however, this is 'a good read' — so if you know a computer aficionado who likes a ripping yarn, look out for this book.

The Hut Six Story tells an altogether different tale but it is one



that has a special place in the history of computing. It tells the inside story of the breaking of the Enigma Codes — the cyphers used by the Germans in World War II — presenting fascinating details of the mathematics this involved. The main interest of the book is that it expands on an episode which has previously only been the subject of historical accounts by filling in the technical details.

The account is a personal one by Gordon Welchman, one of the cryptanalysts involved, telling the story about the people who worked in Hut Six in the grounds of GCHQ (Government Communications Headquarters) in Bletchley Park. Before reading this book, the only name I'd heard of was that of Alan Turing — as it turned out he hardly figures in this book, but a lot of others do! The final section of the book airs the fears of the author, who is still working on military studies for the MITRE Corporation in the USA, about how unprepared our society is for war.

On an altogether more frivolous note (please excuse the pun) you might be interested in the **BYTE Book of Music.** This is a collection of articles which mostly first appeared in *Byte* magazine between 1977 and 1978 so, although it's interesting stuff, it's actually rather dated. There is quite a dearth of information about how to make music with computers so let's hope *Byte* books bring out a revised edition soon.

Lots of publishers are rushing to get new titles on the ZX Spectrum out before Christmas. The first one to arrive here was **Programming Your ZX Spectrum** by Tim Hartnell and Dilwyn Jones. This book introduces ZX BASIC step-by-step, giving programs to illustrate the use of the various keywords. The book contains more than a hundred programs and routines so it will keep anyone with a new Spectrum occupied trying them out. Another book that's already available in the bookshops is Ian Sinclair's **The ZX Specrum and how to get the most from it.** This book starts with a careful explanantion of how to get your Spectrum working and how to enter your very first programs and then goes on to cover lots of topics in ZX BASIC at a fairly advanced level. In this respect it's a book for the user experienced in other machines as well as the newcomer to computing.

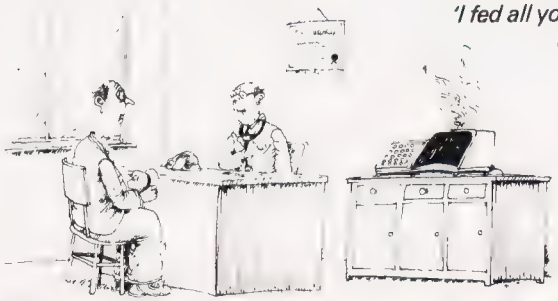
If you want to introduce a little laughter and jollity into the Christmas proceedings, look out for **Microphobia,** a collection of witty cartoons that sends up anything with a chip in it. Well, that's an overstatement as there are really only two types of joke in this book — video jokes and computer jokes. There are more than a hundred cartoons included and they are impossible to describe so instead I offer you a sample

(* Modesty, and a certain amount of vested interest, has prevented our reviewer from mentioning two titles that will shortly be released by Granada Technical Books. **The Spectrum Programmer** by S M Gee is a step-by-step guide to programming in BASIC on your ZX Spectrum and includes several complete programs and, so I'm told, lots of information on the graphics and sound capabilities.

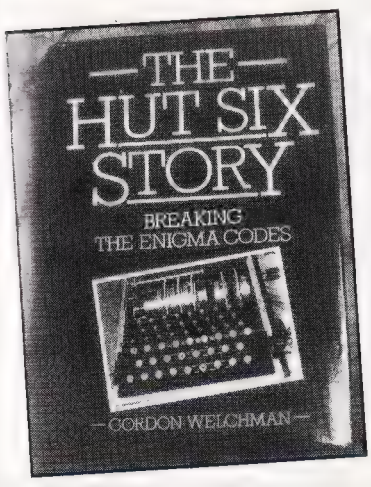
The Spectrum Book Of Games by Mike James, S M Gee and Kay Ewebank provides 21 program listings which are all fully documented so you can not only learn about the way that the programs are written but have fun at the same time too. The programs will also be published on cassette for those with aching fingers. Both the above should be available by Christmas and will cost £5.95. Ed. *)

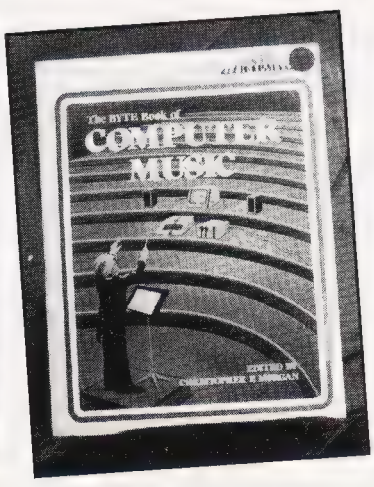
The books included in this month's selection were:

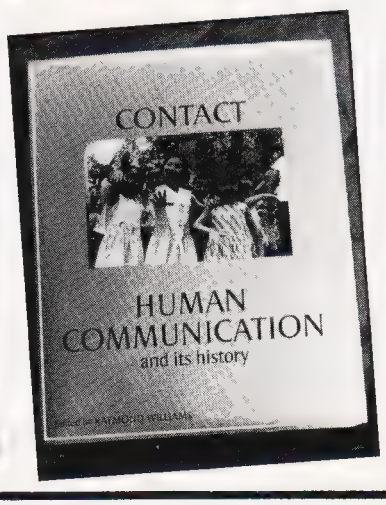
Contact: Human Communication and its history, edited by Raymond Williams, published by Thames and Hudson (1981), hardback, 272 pages, £9.95.
Micro Man: Living and Growing with Computers, by Gordon Pask and Susan Curran, published by Century (1982), hardback, 222 pages, £8.95.
The Soul of a New Machine, by Tracy Kidder, published by Allan Lane Press (1982), hardback, 254 pages, £7.50.
The Hut Six Story, by Gordon Welchman, published by Allen Lane Press (1982), hardback, 326 pages, £8.95.
The BYTE Book of Music, edited by Christopher P Morgan, published by Byte Books (1979), 144 pages, £9.75.
Programming the ZX Spectrum, by Tim Hartnell and Dilwyn Jones, published by Interface (1982), 231 pages, £6.95.
The ZX Spectrum and how to get the most from it, by Ian Siclair, published by Granada, 130 pages, £5.95.
Microphobia — How to survive your computer, by Martin Honeysett, published by Century (1982), 114 pages, £2.50 (hardback, £4.95).

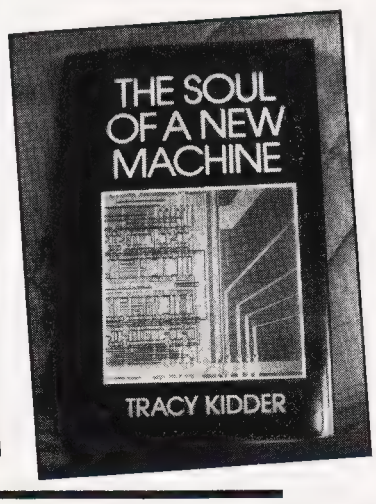


'I fed all your symptoms into the computer, Mr Bilkins, and it died.'









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PRINTOUT

Dear Sir,

With reference to the Case Converter article published in September's **CT**, *I modified my TRS 80 to display lower case but I was rather disappointed with the driver routine provided. The attempt to simulate a conventional typewriter with the shift key giving upper case led to peculiar results with the arrow keys. Having eliminated the part of the driver which swops the two cases, I decided to look for a more convenient location in the memory map.*

Looking through my copy of **Microsoft BASIC Decoded & Other Mysteries for the TRS 80** *by James Fervour, I noticed that there is an area in the communications region of the map which is used as a stack area during the initial program load phase (IPL). After the IPL this area is apparently unused. Using this area means that the driver can be loaded and forgotten unless the computer re-boots and the IPL phase runs again. Pressing the reset button does not affect the operation of this driver.*

My BASIC loader is attached.

Yours faithfully
Martin H Goose
Hemel Hempstead

```
 10  CLS:PRINT CHR$(23)
 20  PRINT @512,"LOWER CASE DRIVER
     BEING LOADED"
 30  DATA 221,110,3 :REM LD L,(IX+03)
 40  DATA 221,102,4 :REM LD H,(IX+04)
 50  DATA 218,154,4 :REM JP C,49AH
 60  DATA 221,126,5 :REM LD A,(IX+05)
 70  DATA 183       :REM OR A
 80  DATA 40,1      :REM JR Z,$+1
 90  DATA 119       :REM LD (HL),A
100  DATA 121       :REM LD A,C
110  DATA 254,32    :REM CP 20H
120  DATA 218,6,5   :REM JP C,506H
130  DATA 254,128   :REM CP 80H
140  DATA 210,166,4 :REM JP NC,4A6H
150  DATA 195,125,4 :REM JP 479H
160  START=16480
170  FOR ADDRESS=START TO START+29
180  READ BYTE
190  POKE ADDRESS,BYTE
200  NEXT ADDRESS
210  MSB=INT(START/256)
220  LSB=START-256*MSB
230  DCB=16413      :REM START OF VIDEO
     DEVICE CONTROL BLOCK
240  POKE DCB+1,LSB :REM PUT NEW VIDEO
     DRIVER ADDRESS
250  POKE DCB+2,MSB :REM INTO DCB
260  PRINT @640,"Lower case driver
     loaded":PRINT
```

Dear Sir,

Being the proud owner of a Sharp MZ-80B Personal Computer has many advantages. One's fingers flit easily from key to key to construct programs of seemingly unlimited length in any language one cares to let it deal with. Its graphic abilities are bounded only by time and imagination and certainly not the high resolution irridescent green CRT (or Magi-pad as we know it.) At about £1,000 per machine it even plays music (but who wouldn't for that amount of money)?

However, I write to you concerning its sole disadvantage as I see it. Perhaps because of the price, perhaps because they're only owned for their looks, or perhaps all other owners are well addressed personal keyboard junkies, or maybe I'm the sole possessor of THE MZ-80B, but whatever the reason, nobody writes about it.

Is there anybody out there who has tackled the internal intricacies of this machine's monitor language without it laughing at you having to press the reset button again? Has anyone got to grips with the entrails of its hardware and unravelled the mysteries of its communications ports such that it now controls their very existence? Speak to me, I'm going mad.
CHECK SUM ERROR.
AAAHAHAHA

Yours in the dark,
D R Digby Roberts
Northamptonshire

Dear Sir,

"What was that name again..."
I was highly amused by the news item in your September issue on my program 'The Nowotnik Puzzle'. I felt I had to write and confirm that, yes, I do actually exist!

When we decided to go ahead and market the puzzle, we felt that the use of my East European surname was entirely appropriate. After all, we believe that it is capable of setting a challenge equal (but different) to that famous cubic puzzle with East European origins.

Your readers may also be interested to know that Spectrum versions of the puzzle will soon be available.

Yours faithfully,
David Nowotnik
Bucks

Dear Sir,

I have been taking your magazine for a little over 12 months now and on the whole it suits me fine, so much so that I have ceased to take any other.

However, I do have a criticism and this is your over protective attitude to software pedlars, probably brought about by their financial contribution to your wellbeing.

Copyright is not a licence to print money — if software prices were brought down to a mass production level then it would become cheaper to buy the original rather than a copy.

For example, I can buy locally, five blank tapes for £1, ie 20 pence each, retail. To record on both sides using modern techniques would take about 15 seconds and if done 100 at a time — a cost of five pence each. In my estimation no tape should cost more than £1 if sold on a mass production basis.

On this basis many more tapes would be sold, profits would be higher both to the pedlar and the licencee, the copyist would be out of business and the tremendous amount of private copying that goes on would be reduced to a minimum.

When you can pay up to £20 for a program and at the same time buy a micro for less than £70, it's obvious that someone is being ripped off. Such a state of affairs positively invites the entrepeneurs to come in, and good luck to them say I for they will inevitably bring down prices to a reasonable level.

I don't suppose this letter will get into print, but at least, Mr Editor, you will have the discomfort of knowing that we are not all suckers out here.

Yours faithfully,
Harvey Fruish
Northampton

(* The cost of tape (even bulk buying) can be more than you state, bearing in mind that a high quality mechanism and tape is preferable. The cost of duping is dependant on the method selected — high speed duping is likely to be cheaper but is also more prone to poor copies. (This is also dependent on the master copy — ▶

reel to reel copies are best, but this in turn adds to the expense — and the machine for which the tape is required — some computer tape interfaces provide a master that is easier to copy than others.)

Other items you may like to take into consideration are the cost of the initial equipment — micros, printers, monitors, tape recorders, etc — the overheads for the company residence, and, of course, the high price of labour (someone has to sit there and dupe the copies and then put them in their little boxes).

Consider also the labels, advertising, packaging, postage, etc, they don't come too cheap either.

Two other important aspects to be considered are the quality control and technical queries, and who is going to actually write the programs. As you may or may not know, answering enquiries can be very time consuming, and as for program writing, if I was to tell you how many hours were spent on The Valley you probably would never believe me. It all costs money.

I'm sorry to go on at length but I believe it is a question that is important to answer. If you are just sitting at home copying the odd tape then, of course, it's cheap — but consider some of the responsibilities and costs involved in a commerical set-up and you'll wonder how they manage to keep the prices so low! Peter Freebrey, CT Software*)

Dear Sir,

I was so impressed by the tape indexer program written for the Commodore PET in your September issue that I set about converting it to run on my VIC-20. I have detailed below the changes I made to the program in the hope that other VIC users may benefit.

(1) Change PET POKE locations 158 and 623 (lines 56 and 80) to VIC locations 198 and 631.
(2) The program can be greatly enhanced by controlling the VIC CN2 cassette unit from within the program and printing suitable prompts for the user to follow on the screen.

(a) To stop the cassette, POKE 37148,242 and to restart it POKE 37148,254.

(b) To test if the play key is pressed (or ffwd/rew — VIC can't tell the difference) use PEEK (37137) AND 64. The result will be 0 if a key is pressed or else 64.

(c) To wait until the play key is pressed, use WAIT 37137,64,64 and to wait until a key is released (after POKE 37148,242) use WAIT 37137,64,0 (after POKE 37148,254).
(3) VIC and PET users will know that pressing the Shift and Run/Stop keys will LOAD and automatically RUN the next program on tape, although I have not seen this documented anywhere. This key combination is CHR$(131) (which I found out by mistake) and can be used in the program to replace lines 56 and 58 as follows:

```
56  POKE 198,1:POKE 631,131:PRINT
    "[HOM]"
```

Yours faithfully
Michael Maxwell
Hampshire

Dear Sir,

Mr Fagandini's idea to delete the SYS 1000 call (as suggested in his letter in September's Printout) certainly succeeds in removing the SYS statement and the program continues to RUN — but the protection is no longer operative. Inspection of the program memory in a PET confirms that the SYS call is no longer in the program.

Since the ASCII code for delete (on the PET) is 14 Hex and the ASCII code for A is 41 Hex, the required line can be produced by:

```
150  DIM A(50):SYS 1000"AAAAAAAAAA
```

followed by a Carriage Return. Now, enter the monitor with a SYS 1024 and look at the early program memory with:

```
.M 0400 0480
```

Find the string of 41 Hex locations and change each to 14 Hex. Exit from the monitor with .X and now LIST. Behold, the SYS call has been deleted.

On RUN however, a Syntax error is reported. I'll leave you to overcome this simple three byte to six byte problem using a BASIC statement!!

Playing with the PET codes 0 to 20 Hex revealed a further improvement. With a single character A changed from 41 Hex to 15 Hex, all of the statements prior to this are deleted and now you can insert a dummy line!! Try:

```
150  DIM A(50):SYS 1000..."A
```

On LIST you will get:

```
150  REM ** DUMMY LINE
```

Of course, a completely misleading logic statement can be inserted here to confuse any knowledgable programmers.

The only way to find this protective system is to read the machine codes using the monitor or possibly (?) list on a printer.

Yours faithfully
Graham Blakemore
Loughborough

PS Could Mr Fagandini's letter have been meant as a joke? His idea has certainly proved interesting to implement.

Dear Sir,

We understand that you recently published a review of the Midwich MicroController, and write to inform you that this product has now been totally transferred to Datac Ltd, as from 29th July, 1982.

Could you please publish this information and state that we are now the manufacturers and suppliers of the MicroController, Griffin & George continue to sell the low voltage version into the Educational market.

Yours faithfully
D. H. Starbuck
Chairman
Datac Ltd
Tudor Road
Altrincham
Cheshire
WA14 5TN

Dear Sir,

On the 20th of August I telephoned Grundy with an order for the NewBrain Model AD, requesting that it be delivered in time for my wife's birthday on the 1st of September.

It arrived on August 27 and three days later a small birthday card for my wife arrived with my invoice. Is the speed of delivery a record?

I have been very impressed with the computer and the company's efficiency, but not with the manual which is woefully inadequate for the machine.

I hope this letter redresses some of the balance of customers waiting months for a micro.

Yours faithfully
David McKinlay
Wolverhampton

Dear Sir,

When I read the opening paragraph of Mr Cytera's enquiry in the July issue of your magazine, I almost thought I had written it myself.

I do not know Harding's book, but I have made the same search

through similar books and I present a list of the titles for any readers with a similar problem.

Chess Skill in Man and Machine
Selected by Peter W Frey
Published by Springer-Verlag
ISBN 0-387-03957-2

Creating a Chess Player
Peter W Frey and L A Athun
BYTE, *October 1978 — January 1979*

An Exchange Evaluation for Computer Chess
D K Sprachlen
BYTE, *November 1978*

First Steps in Computer Chess Programming
D K Sprachlen
BYTE, *November 1978*

A Complete Chess Tutorial
N D Whaland
BYTE, *October 1978*
(This article also contains a further list of literature to be consulted.)

The Technology Chess Program
J J Gillogly
Artificial Intelligence *(1972)*

Yours faithfully,
T H Van Reenen
Republic of South Africa

Dear Sir,

We are enjoying **Computing Today**, *especially the program to compute Easter day in the last issue. As you also invited readers to send programs in FORTH, we translated the Easter program into FORTH and present you two versions of it. Both programs follow closely the program in BASIC so your readers can compare the languages, especially the second version, where the variables are defined in separate FORTH words.*

Yours faithfully,
K Huni
Switzerland

```
SCR # 1
  0       ( ******    EASTER DATE    ****** )
  1 : OSDA     DUP 19 MOD 1+ SWAP 2DUP
  2      100 / 1+ DUP 3 4 */ 12 - SWAP
  3      8 * 5 + 25 / 5 - SWAP >R ROT 5 4 */ R - 10 -
  4      ROT 11 * 20 + ROT + R> - DUP
  5      0< IF 30 + ENDIF DUP 29 > IF 30 MOD ENDIF
  6      DUP 24 = IF 1+ ELSE DUP 25 = IF ROT 11 >
  7      IF 1+ ENDIF ENDIF ENDIF
  8      44 SWAP - DUP 21 < IF 30 + ENDIF
  9      DUP ROT + 7 MOD - 7 + DUP 31 > F
 10      ." EASTER DAY IS APRIL " 31 - . ELSE
 11      ." EASTER DAY IS MARCH " .
 12      ENDIF ;
 13      ;S
 14
 15
```

```
SCR # 1
  0       ( ******    EASTER DATE    ****** )
  1   0 VARIABLE    YYYY
  2 : F-G    YYYY & 19 MOD 1+ ;
  3 : F-C    YYYY & 100 / 1+ ;
  4 : F-X    F-C 3 * 4 / 12 - ;
  5 : F-Z    F-C 8 * 5 + 25 / 5 - ;
  6 : F-D    YYYY & 5 * 4 / F-X - 10 - ;
  7 : F-E    F-G 11 * 20 + F-Z + F-X - ;
  8 : F-E2   F-E DUP 0< IF 30 + ENDIF DUP 29 > IF 30 MOD
             ENDIF
  9          DUP 24 = IF 1+ ELSE DUP 25 = IF F-G 11 > IF 1+
 10          ENDIF ENDIF ENDIF ;
 11 : OSDA   YYYY ! F-E2 44 SWAP - DUP 21 < IF 30 + ENDIF DUP
 12          F-D + 7 MOD - 7 + DUP 31 > IF
 13          ." EASTER DAY IS APRIL " 31 - . ELSE
 14          ." EASTER DAY IS MARCH " . ENDIF ;
 15   ( TO ENTER YEAR AND TO RUN: XXXX OSDA )      ;S
```

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PYTHONESQUE (£16) is a rather unusual adventure game. For copyright reasons we can't tell you what inspired the game, but if you've got a 32K PET/CBM you can find out — and have fun at the same time.

And now for something completely different. **ROBBER (£12)** is a 16K adventure that finds you on the wrong side of the law; or perhaps you'd prefer **HAUNT (£12)**, an eery encounter with ghouls and ghosts that'll give you sleepless nights! That old favourite, the **HITCH-HIKERS GUIDE TO THE GALAXY (£16)** is still available for 32K PETS, along with that other masterpiece from the irrepressible Bob Chappell, the **CRACKS OF DOOM (£16)**.

If playing arcade games is your kind of fun then you've come to the right paragraph. Believe it or not we're more than doubling our range with new games like **BLAKATAK**, **MANGROVE**, AND **TANK ZONE** AT **£8**, or **INVADERS PART 2** and **COSMIC BANDIT** for only **£6**. And there's a real treat in store if you've got 16K of memory — a superb PET version of **SCRAMBLE** for just **£10**!

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Iolo Davidson

CHEAP PRINT

This article will present you with what must be the cheapest way to get your name in print!

The single most useful add-on for a computer must be a printer. Isn't it a pity that they cost more than the computer itself? Wouldn't it be smashing if you could get a full page, plain paper printer for, say, £25? Aren't you glad you bought this issue, because we're going to tell you how to do just that.

The GPO have been revolutionised by the microprocessor just like everyone else and in the process, tons of working but outmoded equipment has been sold as scrap, including small mountains of teleprinters. These are normally of no use to computer buffs because they use the Telex code, a five unit code which bears no resemblance to ASCII, and because of this they sell for very little. However, it is not terribly difficult to get around this drawback the cheap way, with software, and *Computing Today* is going to make it even easier by publishing a full listing and all software details for the NASCOM next month. In this issue we will deal with the hardware.

CHEAP AND CHEERFUL

Most surplus Teleprinters will be Creed 7Bs or 7Es. These are not only cheap to buy but very cheap to feed, as they will accept either plain 8½" rolls or ordinary typing paper, and the ink ribbons are actually available in High Street shops. The character set is somewhat limited, with upper case only alphabet and a shortage of mathematical symbols, but it is produced in a quality typeface similar to a daisywheel, and is much more readable than the cheaper dot matrix output. These machines are wholly mechanical in operation which inevitably means that they are slow and noisy. However, you can't have everything. Slow means 50 baud, but that's not as 'baud' as it sounds because there are fewer bits per letter. It works out to about 6½ letters per second on a straight run of text. Mixed text and figures prints more slowly because the Teleprinter must be shifted from figures case to letters case, or ***vice versa,*** by the transmission of an extra shift character. In practice, this is only noticeably slower when printing out a Hex dump. The Creed Model 75 ***can*** be made to run at 75 baud, but an increase in noise as well as speed results.

Obtaining a Teleprinter can be a bit of a treasure hunt, leading one through haunts of gypsies and scrap dealers to the white elephant's graveyard, or alternatively you could 'phone a few of the dealers in surplus equipment who advertise in the electronics magazines. ***Electronics Today International, Computing Today's*** relative, has such ads (***Computing Today's*** are rather more up-market). When looking for a machine it is important that the distinction between a Teleprinter and a Teletype is clear. A Teletype is an ASCII coded apparatus and therefore commands a much higher price.

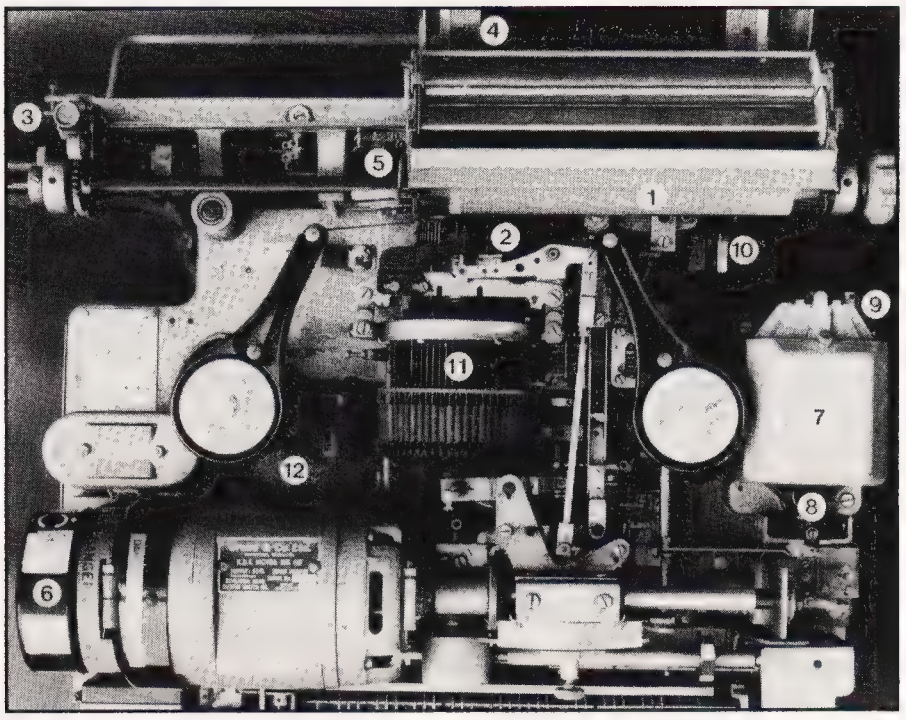
The most important thing to look for when selecting a Teleprinter is to ensure that the motor will run from the mains. Many of these machines have a 160/220 Volt DC motor, and while

these will usually work directly from half-wave rectified mains by merely putting an IN4004 in series with the motor and setting the motor's link to the 220 Volt position, it is easier to have confidence in the proper mains version. Some army surplus models have 24 Volt motors, which require huge amperages and should be avoided. Occasional machines will have pin feed platens which require perforated edge paper; these should also be rejected unless you particularly want this feature, as they won't work with ordinary paper. Some machines will have a paper tape punch incorporated. This will be of use to people who wish to use their computer to prepare Telex messages for transmission, but is of no interest otherwise.

Creed 75s without a keyboard can be obtained more cheaply than the same model with a keyboard, which is ideal as the keyboard is redundant in this application. For the same reason, a damaged keyboard should not dissuade you from purchase, and may be an excuse to wheedle an extra discount. Visible damage elsewhere, however, is a clear signal to pass by. The paper carriage in particular should be closely inspected, as it is somewhat exposed. Make sure that the platen turns and slides easily, and that its surface has not been grooved by long usage. No dealer will give any guarantee on surplus equipment. So be fussy, and extract a promise to make good any parts which turn out to be actually missing before you part with your money. You won't get a refund, but a decent dealer should agree to swap any unit which is completely defunct. The price will vary, of course, but I have recently seen them advertised for as little as £18, and once bought a few for even less!

ON THE FIDDLE

These machines are quite complex mechanically and have literally hundreds of adjustments. It is preferable to leave them all alone! If you have to change something, make sure that you have puzzled out the purpose and effect of the proposed fiddling before you dig in with a screwdriver. Do not on any account attempt adjustments while the unit is plugged in. The operation of the machine can be studied by turning the motor by hand and observing the action, while moving the signal magnet arm manually. Remember that the unit was probably working

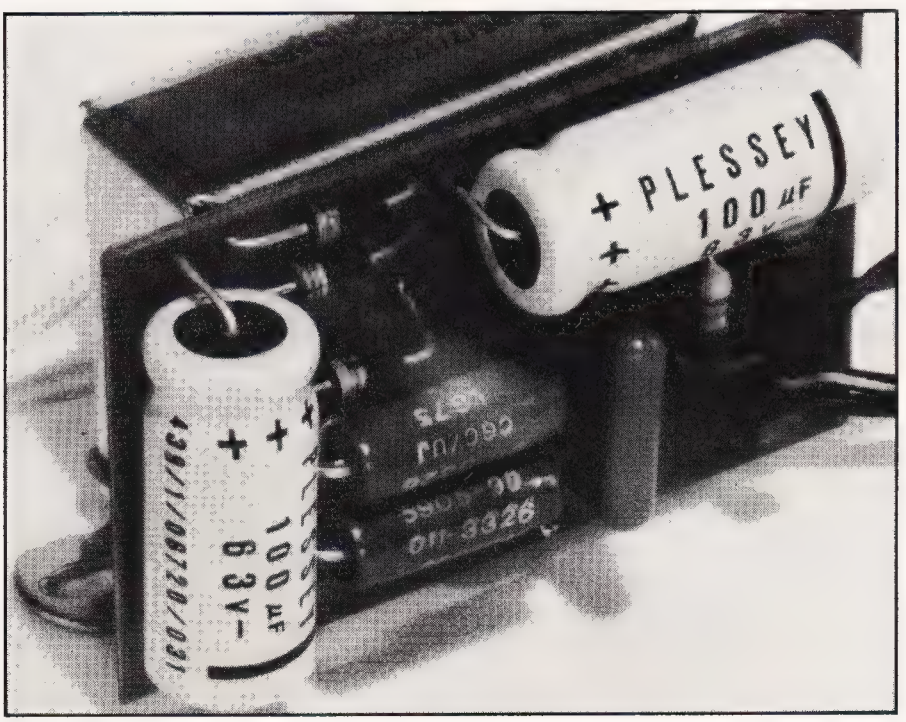


The vital parts of the Creed 7E Teleprinter. Key: 1 — platten (cork or rubber), 2 — typewheel, 3 — manual Carriage Return and Line Feed adjuster (double/single LF), 4 — paper holder for 8½" by 3½" rolls, 5 — paper release lever, 6 — motor speed regulator drum, 7 — signal magnet, 8 — signal armature, 9 — magnet adjustment screws, 10 — carriage removal catch, 11 — mechanical decoding drum, 12 — muck and oil (They're all like that, chief!).

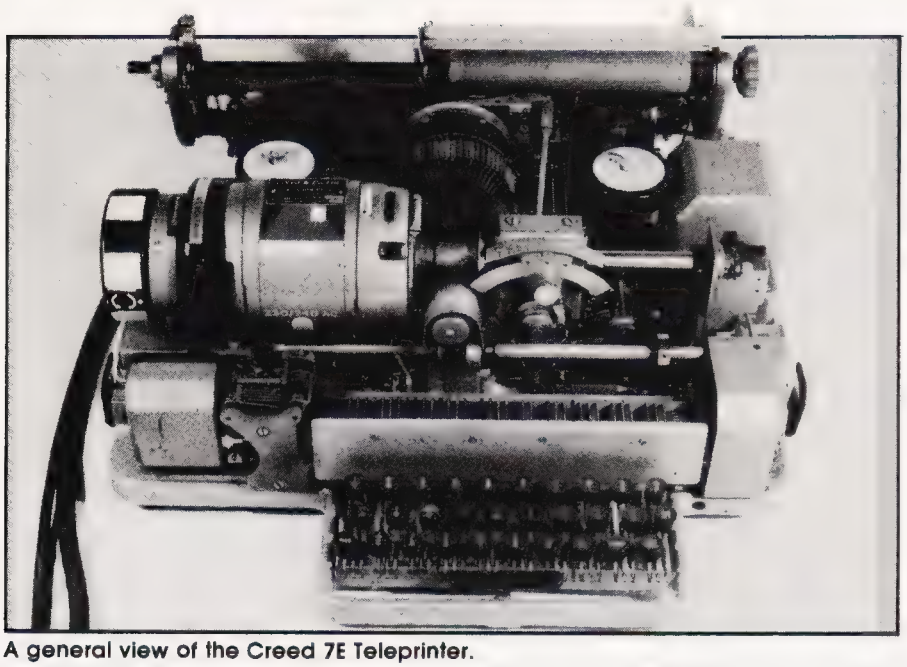
normally right up until the day it was junked, and random fiddling is more likely to cause trouble than not.

The interfacing hardware is kept simple and cheap by doing all the code conversion, serialisation and timing in software. The interface therefore only needs to boost the level of the signal high enough to operate the magnet.

This signal is supposed to swing from + 80 to − 80 Volts, but this high voltage is partly to allow for sending Telex over long distances by land line. In practice, + or − 50 Volts is sufficient to operate the magnet, and since the current needs to be limited by ballast resistors to around 30 mA, a single 50 Volt supply can be made to appear bi-directional to the signal



The interface circuitry assembled on its PCB and awaiting installation.



A general view of the Creed 7E Teleprinter.

magnet by supplying both ends of the coil constantly through ballast resistors, and grounding one end or the other to reverse the flow through the coil. Using a voltage doubling rectifying circuit allows us to use a common transformer voltage, and the cost of the interface should certainly be less than a fiver.

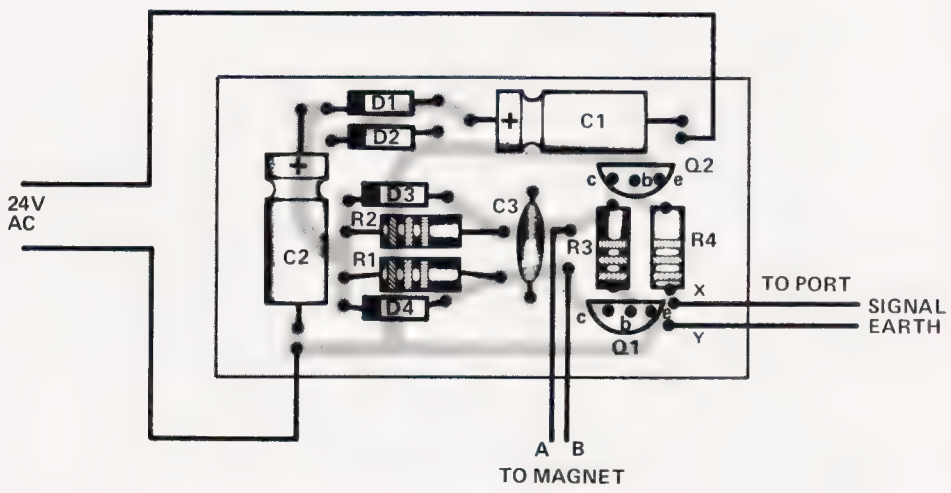
Using the PCB layout provided will produce a unit small enough to fit within the base of the Teleprinter, and the mains supply to the transformer can be taken from the Teleprinter's tag strip. The PCB can be tied to the transformer and the transformer mounted with self tapping screws in a convenient recess. Leads A and B go to the signal magnet tag strip. Details of this will vary from machine to machine, but basically there are four tags. The centre two of which are joined as a centre-tap to which no connection should be made. Which of the other two is A and which is B can be found by experiment. The correct connection will cause the armature of the signal magnet to move towards the motor when the interface is powered with no signal applied to it.

When the interface is not powered, the armature should click freely from side to side without any preference for one or the other. Should this not be the case, there is an adjustment at the back of the magnet with which to even things up, but first try turning the motor by hand to find a position where the armature moves freely. It should stick slightly to both sides due to the polarising magnetism. But this should be equal in both positions.

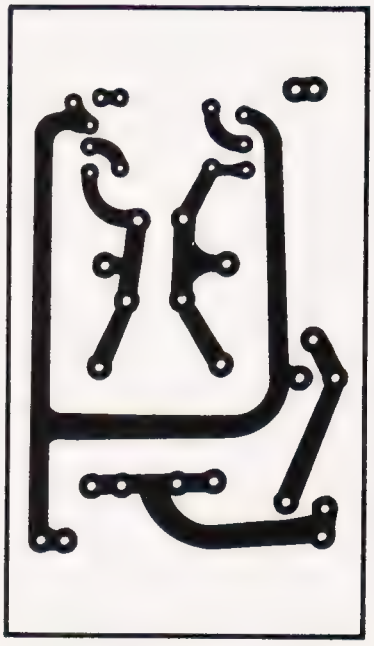
FOR THE LAST TIME . . .

The remaining connection is that between the interface and the computer. Point X goes to the port used and point Y to the computer's ground. The port used will depend on the computer and software used, but should have a latching 5 Volt output. The program for the NASCOM uses the spare output (bit five) of the keyboard port, which avoids typing up the PIO. This is pin 14 on the NASCOM 1 keyboard header plug and pin 6 on the NASCOM 2 plug, but beware, these plugs are not numbered like an IC, but in a zig-zag fashion. A ground connection can be found in the same plug. Convenience is best served if this connection is made via a polarised plug and socket, and perhaps also an isolating switch.

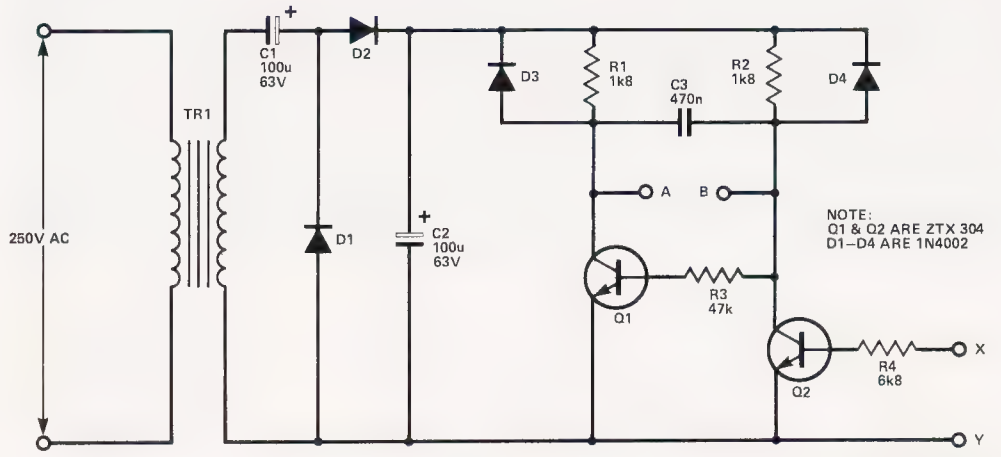
Connection to other computers is possible if a suitable code conversion program is available, and will depend on the details of that program. I know of programs for the UK 101, Superboard, Triton and Acorn ATOM, so ask your users group. Failing that, the NASCOM program to come will be in the form of an assembler listing with useful notes which should enable the keen and/or desperate



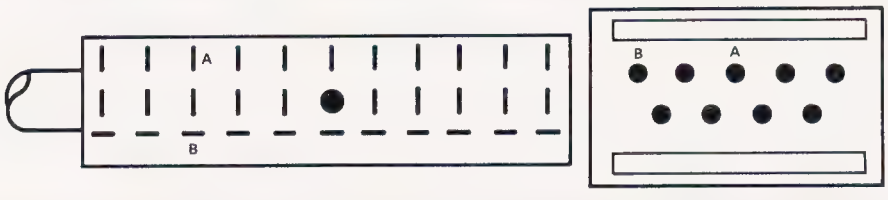
The component overlay for the PCB.



The PCB foil pattern.



The interface circuit. Note that TR1 is a 24 V 100 mA type.



The interface connection points. Points A and B of the interface circuit connect to the two types of PO plug as shown below or to the tag strips in the base of the machine. Which you get depends on the machine you buy but can be traced back from the plug connections. Point X connects to the spare output (Bit 5) of the keyboard port, this is pin 14 on the NASCOM 1 or pin 6 on the NASCOM 2 header plug. Please note that the NASCOM 2 header plug pins are not numbered like an IC. A connection should be taken from point Y to ground.

to adapt it to their own machine.

Paper is available cheaply from NCR, but they have a minimum order of £15, which is more than a box of ten rolls costs, delivered. Ask for Telex rolls and make sure they are the 3½" diameter type, unless your Teleprinter will accept the larger 5" rolls.

There are rather a lot of warning labels on these machines. These boil down to the single admonition to disconnect the power before exposing your digits to the mechanism. Good idea!

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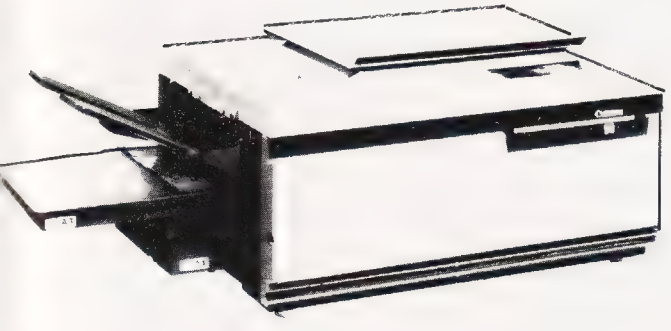

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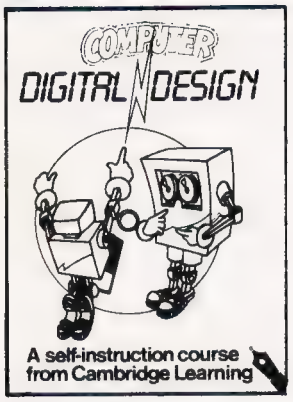

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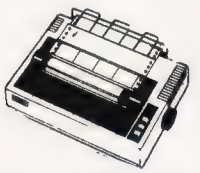

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#FILE

The Editor's gone away, the world heaves a sigh of relief! Trouble is, he left this little article behind . . .

What do an airshow and a new Science Fiction film have in common? Well, apart from being items of interest your Editor has visited in the last month, they both show off the way computers and computer controlled devices have been exploited to kill people!
In all fairness, though, I must point out that this month's 'news' is a little out of synchronisation with the real world. My excuse for this tardiness is that the warmer climates of Silicon Valley are beckoning and it's a little difficult to guarantee the delivery of post across the Atlantic — even in these days of Information Technology!

SERIOUS STUFF

To begin this month's extravaganza, however, let me deal with a couple of your enquiries. First out of the mailbag comes the following from Mr A Robinson of the RAF:

Are you planning to print your programs in Bar Code form so that we can read them into our computers with a Bar Code reader? Or, perhaps it isn't that easy.

It is a lovely idea and one which crops up every so often from someone or other. Yes, in theory it is perfectly possible to produce program listings in Bar Code form and to read them into a computer. However, a number of small obstacles tend to render this plan impractical. First, how do you get a computer to print in Bar Code form? Well, you need a special printer to start with and then for every system that you wish to use it with, you will have to write a driver program which outputs the BASIC in Bar Code fashion.

Sounds to be a trivial if laborious problem, so what's the next stumbling block? BASIC, as readers will probably be aware, tends to vary from machine to machine, both in the structure of the language and the way in which the programs are stored. So, for each particular type of computer, it would be relatively easy to dump a program out in Bar Code format and load it back into an identical system. Loading programs from one system to another becomes a more complex problem!

The process of providing Bar Code format programs is used by Hewlett-Packard for their programmable calculators and by Casio for loading tunes into the latest VL-Tone programmable organ. But, and it is a big but, the problems involved in using it in magazines are such that the only publication which tried (an American title whose name currently escapes me) stopped doing it when the number of computers available went above three or four.

So, sadly, it is a nice idea that would simply involve too much work and, unfortunately, still be prone to the sort of errors that we suffer with directly printed listings.

The second letter for this month comes from Mr J Bailey of Chesterfield who asks:

Is there a random number program available for the TRS-80 Pocket Computer as it does not have the RND function in its BASIC command set?

Yes, there is and it can be found in the applications program booklet! We also published a modified version in our PC-1211 Programming feature (***Computing Today*** January 1982). Alternatively, try one of the methods suggested in last month's Elegant Programming feature.

RED GO THE FACES, OH!

My filing system is perfectly simple, a large cardboard box which gets emptied when it overflows! Normally this represents a very simple and effective method of keeping everything in order and usually works faultlessly. However, for reasons unexplained, it has suffered a breakdown recently and several people must be patiently waiting for replies to their letters.

One of these individuals is a certain Mr Stonebanks who submitted an idea for a program, a Wordsquare solver, and subsequently submitted the program itself. The problem is, Mr Stonebanks, that we've lost your address so could you please contact us?

ON A DIFFERENT PLANE

The thing that I really love about going to Farnborough every other year is that, being a member of that body of individuals called 'The Press' I get to attend on a day

where 'The Trade' and 'The Public' are absent. Many of you must have tried to shove your way around on the normal Open Days and been squashed in along the runway fence to try to get a glimpse of the latest civil and military hardware. So I thought I'd provide a few photos of the aircraft that took my fancy for those of you who missed seeing them.

The computer side of modern aircraft design passes almost all understanding nowadays. The pilot, certainly of a modern civil aircraft such as the new Boeings and the Airbus, no longer gazes at dials but full VDU displays of status and operational parameters. On the military side, the hardware is getting even more sophisticated with the pilot being forced to use such control systems as voice and even eye movement to control the growing number of devices in his cockpit.

On the ground too, the computer is taking over the role of instructor with the latest generation of flight simulators from firms such as Rediffusion providing an uncannily 'real' flight that never gets more than a few feet off the ground. Those of you who may have seen the recent series of special programmes from the BBC Tomorrow's World team would have seen some of the equipment in the programme 'Zero Flight Time'.

The other thing I really enjoy about airshows, no matter where they take place, is the opportunity to sit on a lovely grassy piece of England and devour our special airshow lunch', but the secret of this hamper of goodies will not be divulged for fear of its being copied by the masses!

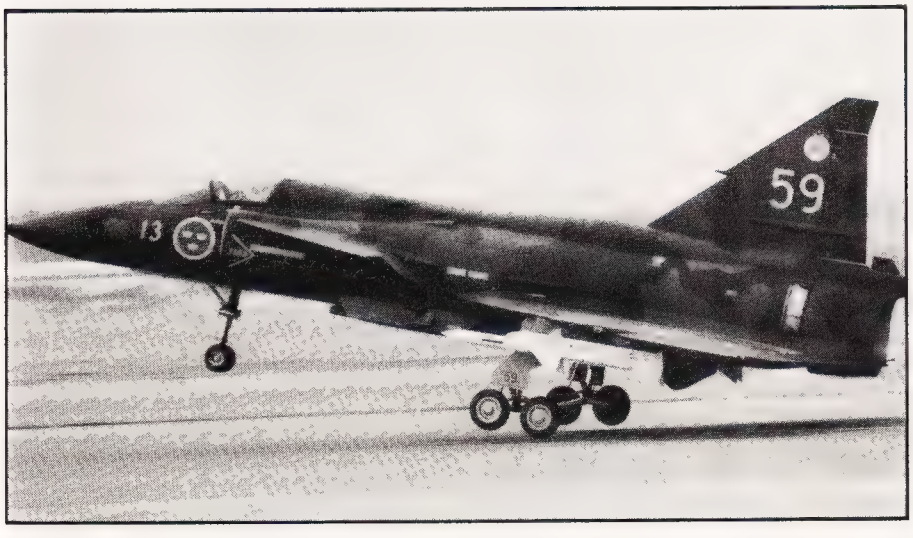
THE NEW REPS

Last month I reviewed Walt Disney's latest offering, ***Tron,*** and, as there were no howls of protest at a computer magazine carrying such material, I thought that I'd slip a word or two about another new Science Fiction film, ***Blade Runner.*** Directed by Ridley Scott, of ***Alien*** fame, it stars that regular Boy's Own hero, Harrison Ford together with Rutger Hauer, a much underrated Dutch actor, and Sean Young, whose looks and presence far outweigh the few words she utters. Indeed, like ***Alien,*** this is a film of moods and events rather than words but this should not be taken as a criticism.

There are some superb special effects which never dominate the film but merely contribute to its feel. The story concerns the unannounced and illegal landing of a group of replicants, reps for short, on Earth in the year 2019. Our central character, Rick Deckard played by Harrison Ford, is an ex-cop of a very special type known as a Blade Runner. These are highly trained detectives who can distinguish between humans and replicants by their responses to certain key questions. The theory behind this is that replicants, being androids, cannot have emotions and hence the title of the book on which the film is based: **Do Androids Dream of Electric Sheep** by Philip K. Dick.

Deckard is persuaded to track down the replicants, led by Batty (Rutger Hauer), and along the way falls somewhat helplessly in love with the replicant makers special product, Rachael (Sean Young). The tracking down of the gang is treated in an almost Marlowe-ish way with continual asides from Deckard explaining the clues and his interpretations of them. The equipment used by a 21st Century cop includes a rather interesting computer terminal which allows a photograph to be scanned and portions of it expanded and reproduced. All the functions are handled by voice control and it is especially nice to see that when the final image is produced it is a 'realistic' blown-up, grainy image rather than a super clear enhanced picture. A small touch, to be sure, but one that adds a great deal of credibility and shows that the special effects director, Douglas Trumbull ***(2001: A Space Odyssey, The Andromeda Strain*** and ***Close Encounters)*** has really thought about the affect that the effects have.

I won't spoil the story (yes folks — this film does have a plot) and I certainly have no intention of revealing the marvellous double ending. A thoroughly excellent film with a good deal of atmosphere and not a small portion of suspense about which the only criticism I can level is that it drifts slightly away from the book, In films which portray the future, or indeed those which portray the past, I like to watch for the verbal or visual slips that can occur — an action or a phrase that is simply out of its 'time'. I couldn't find any in ***Blade Runner*** but I did catch an 'update' on a phrase currently much in vogue in the United States. In the year 2019 the phrase is 'Have a better one' . . .



INTO PRODUCTION

Just as you are sitting down to watch the re-runs of the BBC's Computer Programme (Sundays and Mondays from October 10th) you might be pleased to know that they are already well advanced with their plans for the second series. Currently staggering under the title **'Making the Most of the Micro',** it will concentrate more on the software and applications side of your micro.

The new series will be presented by Ian McNaught-Davis, Mac as he is better known, and produced by David Allen who was the Project Leader for the first series. Among the familiar names that you will be seeing are those of John Coll, author of the **BBC User Guide,** who makes an appearance in the first programme and Ian Trackman, writer of much of the software for both the first and current series.

Indeed, as the first episode was being re-screened on Sunday, the team was assembled at Television Centre for a run through of some of the more complex sections of the first couple of programmes. Our ever-faithful spy was present and promises that we'll be the first to know about any significant details and stories from the series, so watch this space!

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CLUB CALL

Helping you get it together with a user group.

Before we take a look at this month's selection of clubs, an apology must be made to the Fareham and Portsmouth Computer Club. We misprinted their address — it should have read:

23 Sandy Close,
Petersfield
Hants GU31 4HF.

Our sincere apologies to all concerned.

PRESTON ATARI COMPUTER ENTHUSIASTS
177 Forest Drive,
Lytham St Annes,
Lancashire.
Contact: R Taylor
Tel: 0253-738192

PACE is a newly formed group with 50 or so members. Although the group have obvious associations with the Atari machine, encouragement is given to anyone wishing to join; indeed machines such as the Apple, Tandy, VIC-20 and Sharp are also well represented. The group holds monthly meetings on the third Thursday of each month. The membership fee is £5 per adult and £2.50 for those under 16. All members are invited to use the group's library of software and there is an instruction tutorial in BASIC programming at the monthly meetings.

SHARP FREAKS
c/o Micro Solutions Computer Shop (PTY) Ltd,
17 Fenton Road,
Durban,
4001,
South Africa.
Contact: Jon Sawyer.

Not exactly a club this one, more of a commercial enterprise — but there is a newsletter involved which should prove very useful for Sharp users out in South Africa. The newsletter, called Sharp Freaks, contains a wealth of information and news of Sharp products as well as a good selection of program listings.

SWINDON USERS CLUB
47 Grosvenor Road,
Swindon,
Wiltshire SN1 4LT.
Tel: 0793-30770
Contact: Andrew Bartlett.

The club has been formed especially for users of the Sinclair ZX80/81 and the ZX Spectrum. As well as holding monthly meetings, the club also proposes to run a software library for both copyright and non-copyright material.

BRENT USERS GROUP (BUG)
4 Harman Close,
London NW2 2EA.
Contact: Josef Fox

This club produces a bi-monthly newsletter called Input which contains, amongst other things, a problem page, a feature on how to write adventure games and, of course, a selection of program listings. The Brent Users Group meets every last Sunday of the month. Membership of the club is £3 per annum which includes six issues of Input.

CHELTENHAM USERS' GROUP
Arthur Dye County Primary School,
Springbank Road,
Cheltenham,
Gloucestershire.
Contact: Pat Heslip

This group has been formed especially for those interested in the use of microcomputers in primary schools in the Cheltenham area.

MICROCOMPUTER USERS
3 Pinewood,
Holly Tree Village,
Blackburn BB2 5AF.
Contact: R C Pickup
Tel: 0254-22085

This is a new club set up for micro enthusiasts in the Blackburn area. The club has a wide range of micros which their owners bring along to discuss with other existing or prospective owners. The group meet once a month and each meeting usually includes a short talk on a relevant computer topic — for example, the December lecture is about the Commodore 4010 voice synthesiser. Also, a local college is interested in setting up a 6502 programming course providing R C Pickup can find enough interested pupils. Anyone out there in the Blackburn area interested?

PERTH AND DISTRICT AMATEUR COMPUTER SOCIETY
154 Oakbank Road,
Perth PH1 1HA.
Contact: Alastair MacPherson
Tel: 0738-29633

The society meet on the third Tuesday of each month at the Hunters Lodge Motel in Bankfoot. Meetings start around 7.30pm and include a talk about computers, usually with a demonstration. Members are always welcome, either at the monthly meeting or through contact with Alastair at the above address.

SHARP GAMERS GROUP
29 Buttermere Road,
Sheffield S7 2AX.
Contact: Noel Williams

Here is a newly established user group eager to attract new members. The group aims primarily to produce and distribute good games software for the Sharp MZ80K amongst its members and evaluate collectively the games software which is produced commercially. As soon as they are able, the group hope to produce a bi-monthly magazine which will be circulated to members and an annual cassette of the best of the members' software. Membership is £3.29 for an annual subscription.

That's all for this month, but please keep sending in details of your clubs and user groups: times of meetings, newsletters, etc.

If you would like to be included on this page, please drop us a line at:

Club Call,
Computing Today,
145 Charing Cross Road,
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And, if you don't see a club near you, why not write in and see if any readers in your area would like to start up a club with you.

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CT STANDARDS

Our regular page explaining the meaning of the various symbols we use to make programs portable.

It has been very encouraging to see the number of programs submitted using our standard codes for graphics and other non-printable characters. However, it has also become increasingly clear that some of our readers haven't heard of them and this page is intended to set them out once again.

All standards tend to be irksome to adhere to but the ones laid out here are fairly simple and tend to make software easier to maintain by the programmer and simpler to understand for others.

CONTROL THAT CURSOR

Our original standards have now grown with the times. Machines such as the Commodore VIC which have a dual Shift capability can now be incorporated, as can those systems which use Control key functions.

The recently introduced BBC system offers pre-programmed function keys which, we are glad to say, can also be handled by our original coding system. It's nice to see just how well adapted the original standards have become over the last two years! (Indeed, a whole series of books is using them as its ***de-facto*** standard.) The standards for the cursor controls are given in Fig. 1.

```
[CLS]     CLear Screen
[HOM]     HOMe cursor
[CL]      Cursor Left
[CR]      Cursor Right
[CU]      Cursor Up
[CD]      Cursor Down
[REV]     REVerse video on
[OFF]     Turn it OFF
[SPC]     SPaCe
[CTL]     ConTroL key
[fn]      Function key (BBC)
[G<]      Graphic left (VIC/MZ-80A)
[G>]      Graphic right (VIC/MZ-80A)
```

Fig. 1. Our extended set of cursor control standards includes four new functions.

To indicate more than one of the above, an optional number can be placed within the brackets; [4 CL], etc.

The use of square brackets has raised one or two queries. The reason for this choice is that ***most*** of the common microcomputer BASICs don't use them for specific functions. In fact, at least one machine provides an added bonus by returning a Syntax Error if they are found, a useful check in case you type them in by mistake.

The code [SPC] was added to the list of cursor control codes to get over the problem of indicating just how many spaces are contained in the gap in the printout. The other common variant of the code for spaces is used by the ZX people. Their choice was '' and this crops up in the various newsletters they publish.

The code [RVS] has caused a few headaches. This is really specific to the PET where the character set can be displayed in reversed video. On machines which don't have this facility you should either find a character in the set which is the reversed image of the one you want and use that or simply ignore it and use anything else you fancy! Don't forget, you may have to look up and alter the values used elsewhere in the program.

THE GRAPHIC SOLUTION

It soon became obvious that the techniques applied to the confusing cursor controls could also be applied to the graphics symbols. The following standard is now in general use in programs published in *Computing Today*.

If a graphics character or characters are to be displayed in a listing (as opposed to POKE codes or CHR$( ) codes) then they are indicated by the method shown in Fig. 2.

Several people have asked what the relationship between the POKE value for a character and that of its shifted graphic might be. In general the shifted version of any character will be 64 greater than the value of that character. This applies to both PET and MZ-80K systems in all cases.

This can be taken further to include machines which use a pixel graphics set rather than pre-programmed PET-style characters and the series of codes for these is given in Fig. 3. As is nearly always the case there is one machine to which the standard shown in Fig. 3 does not apply — Tangerine's Microtan/Micron. This machine uses a four by two cell structure for its pixel graphics instead of the Prestel/Teletext three by two cell. The method for calculating the value to assign to 'P' is shown in Fig. 4, and is fortunately nice and simple.

MAKING REMARKS

Many people scorn the use of REMs within programs but, during the development at least, they are extremely useful. One of the documentation methods that we use is to keep our back-up copy of our programs on a 300 Baud CUTS tape with all the REMs in place: the working copy, be it on tape or disc, is REMless in order to save space.

It is also good programming 'manners' to give your REMs odd line numbers:

```
3999 REM ** CRASH PROOF INPUT
4000  INPUT "THE NUMBER OF ENTRIES ";A
```

A remarkable number of submitted programs have jumps that go not to the relevant point in the program, but to the REM statement. This can cause severe problems when re-numbering after removing the REMs.

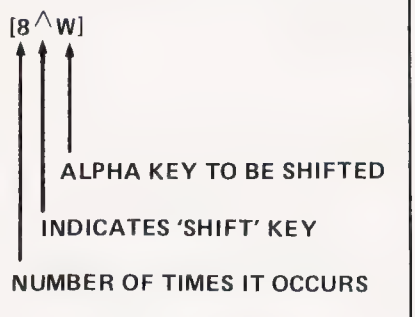

Fig. 2. The way we indicate block graphics on machines like the PET and Sharp. The VIC system of Shift Left and Shift Right is shown in Fig. 1.

1	2
4	8
16	32
64	128

Fig. 4. To convert a Tangerine pixel code into its blocks, simply decode the number into its binary or Hex value and fill in the relevant squares.

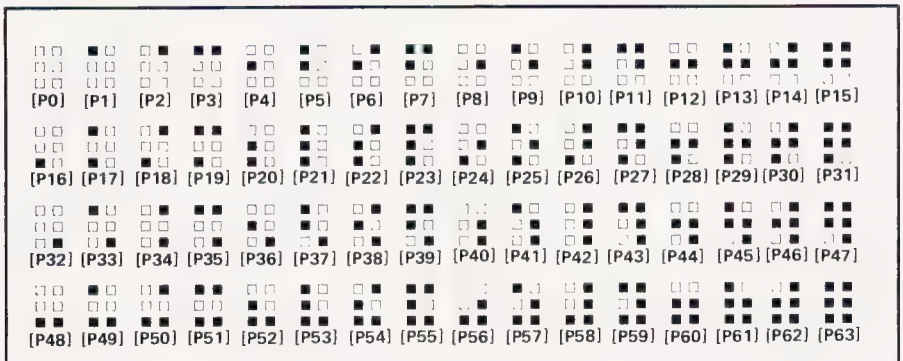

Fig. 3. The standard pixel codes; they will work on most computers which employ this technique as well as for Teletext and Prestel.

BACKNUMBERS

DECEMBER 1979
AIM 65 reviewed, Commodore PET revisited, LIFE on a NASCOM, Memory mapped graphics project.

AUGUST 1980
Multipurpose Records program, String processing language, Computer graphics, Systematic programming methods.

MARCH 1981
Commodore's SuperPET reviewed, 6502 programming course, Golf game simulation, Boolean algebra for computers.

NOVEMBER 1981
Adler's Alphatronic examined, Teletext explained, Speech synthesis board reviewed, Beginners' guide to BASIC.

JANUARY 1982
SuperBrain revisited, PC-1211 programming, FORTH language tutorial, Tandy and Sinclair printers reviewed.

FEBRUARY 1982
The Computer Programme investigated, Graphics for Apple, Sorcerer and Tandy, User programmable characters for ATOM.

MARCH 1982
User report on the BBC Micro, DIY computerised security system, Terminology translated, Classroom computers reviewed.

APRIL 1982
The Valley program, TI-99/4A and Tandy Color Computer reviewed, Report on Centronics 737/739 printers, Basic hardware series.

MAY 1982
Reflections graphics series, Microsoft SoftCard reviewed, Personal computers against mainframes, After the Computer Programme.

JUNE 1982
Two-pass assembler program, Osborne 1 reviewed, Program protection ideas, FORTH simulator in BASIC.

JULY 1982
Advanced BBC programming, Sharp PC-1500 reviewed, Tandy's BASIC displayed, NASCOM toolkit utility package.

AUGUST 1982
Elegant programming techniques, Sinclair's Spectrum analysed, Data storage techniques, 3-D Apple graphics.

SEPTEMBER 1982
Grundy NewBrain reviewed, Special Report on Midwich Microcontroller, Program development explained, Ultra cheap lower case for Tandys, Multiple choice test program.

OCTOBER 1982
Sharp MZ-80A reviewed, DIY spreadsheet program, Subroutine library, Simulating systems on a micro, Into BASIC Pt 1.

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The Jupiter Ace personal computer runs in FORTH, an easily understood language, typically four times as compact and ten times as fast as BASIC. Before the Ace all personal computers used BASIC and FORTH was only available to a privileged few

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If you own a personal computer you will be aware of the limitations of BASIC. You know how slowly your programs run and how quickly your computer's memory gets filled. The Jupiter Ace is your answer.

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The manual is a complete introduction to the world of personal computing and a course in FORTH programming on the Ace.
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"The Ace is an excellent way of using FORTH"
Popular Computing Weekly

"FORTH is an easy language"
Byte

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A catalogue will be sent with every machine, and includes, initially, programs for education and entertainment.

FORTH Finishes First!

Speed Comparison Chart showing times in seconds to perform one thousand operations.

Type of Operation	Jupiter Ace	BBC Micro	Vic 20	Spectrum	ZX81
Empty loop	0.12	0.67	1.3	4.2	17.7
Print a number	7.5	13.5	26	19	430
Print a character	0.62	1.3	3.1	7.5	24
Add two numbers	0.45	1.4	5.5	7.5	28
Multiply two numbers	0.9	1.6	6.5	7.5	32

Because of the difficulty in devising exactly equivalent programs, these measurements should only be taken as a guide.

only £89.95

Designed by Jupiter Cantab

Computer Designers Steven Vickers and Richard Altwasser played a major role in creating the ZX Spectrum and then formed Jupiter Cantab to develop advanced ideas in personal computing. The Ace is the result, another all-British computer to lead the world.

Technical Information

Hardware
Z80A running at 3.25 MHz.
8K bytes ROM
3K bytes RAM

Keyboard
40 Moving-key keyboard with auto repeat on every key and Caps Lock.

Screen
Memory mapped 32 column x 24 line flicker-free display with upper and lower case ascii character set.

Graphics
Chunky graphics (64 x 46 pixels) may be plotted, unplotted or over-plotted (XOR operation). Also, the entire character set (128 characters and their video inverses) may be redefined allowing intricate shapes to be drawn with a resolution equivalent to 256 x 192 pixels.

Control Structures
IF–ELSE–THEN, DO–LOOP, DO–+LOOP, BEGIN–WHILE–REPEAT, BEGIN–UNTIL, all may be mixed and nested to any depth.

Cassette
Programs and data in the compact dictionary format may be saved, verified, loaded and merged. Blocks of memory can be saved, verified, loaded and relocated. All tape files are named. Running at 1500 baud, the Ace will connect to most portable tape recorders.

Expansion Port
Contains D.C. power rails and full Z80 Address, data and control signals. May be used to connect extra memory and other peripherals. IN and OUT words allow port-based peripherals to be addressed.

Data Structures
Integer, Floating point and String data may be held as constants, variables or arrays with multiple dimensions and mixed data types. There are no restrictions on names.

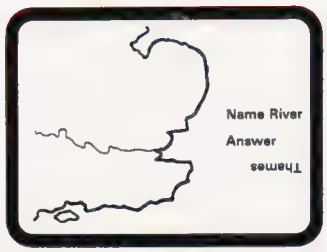
Sound
Internal loudspeaker may be programmed to operate over the entire audio spectrum.

Programming in FORTH

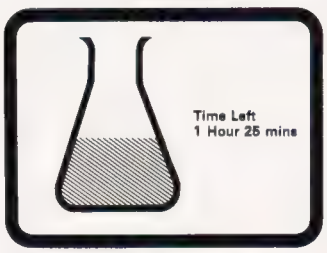
Programming in FORTH
FORTH programs are constructed without line-numbers, as words which are defined in terms of other words that already exist. Consider the following definition of the word **STARS**. Comments are in parenthesis and have no action.

```
STARS          (: starts word definition)
  " *** "      (print 3 asterisks)
  200 100 BEEP (play a note for
                100 mSecs)
```

The semi colon at the end finishes the word definition. Now, whenever you say **STARS** the computer will print out 3 asterisks and sound a short tone. (Notice that the word **BEEP** comes after the numbers it uses, 200 and 100. This characteristic occurs throughout FORTH so you write, for instance, 28 76 + instead of 28 + 76.)
The Jupiter Ace already has 140 FORTH words defined in ROM.

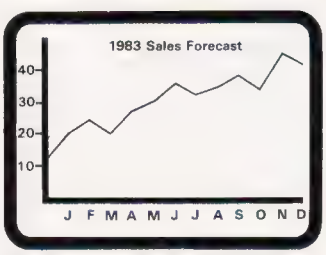


In Schools Teachers already know how quickly children take to computing, and the Jupiter Ace is an ideal introduction. FORTH is an easy and important language to learn and by making learning fun, the Ace can help to teach science, music and many other subjects.



In Laboratories For monitoring and controlling experiments, the Jupiter Ace has many advantages. The language is perfect, even the Jodrell Bank Radio Telescope is controlled in FORTH. The Ace expansion port enables it to be interfaced to almost anything, and the built in quartz timer allows experiments to run all weekend.

At Home The Jupiter Ace is powerful enough to play games as complex as Chess and with sound and high resolution graphics, action games written in FORTH will stretch your reaction speeds to their limits.



In the Office Stock control, Accounts and Financial forecasts are all possible on the Jupiter Ace. With a printer and extra memory attached you can do word processing as well.

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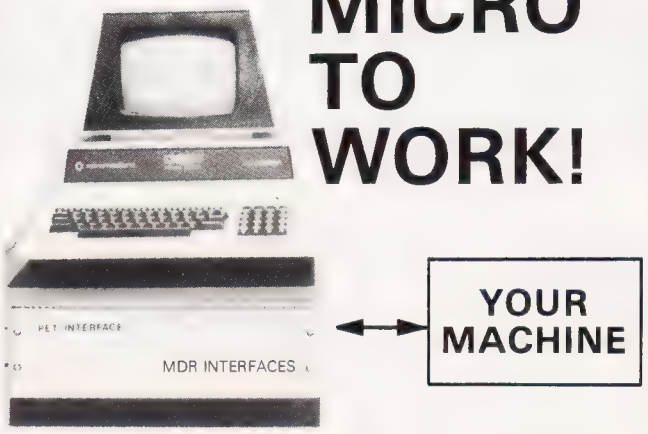

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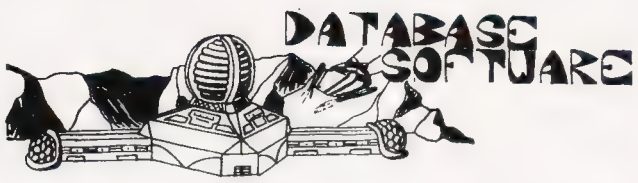

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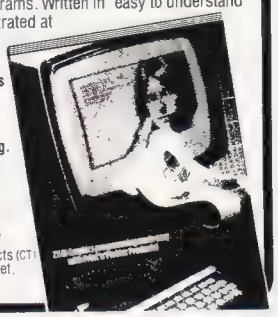

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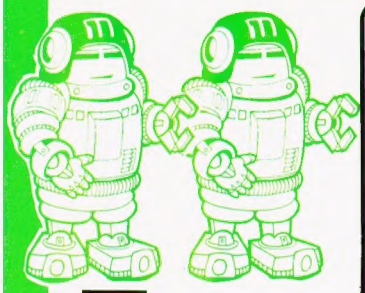

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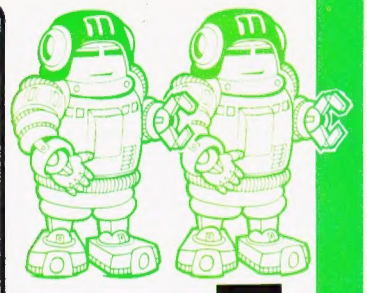

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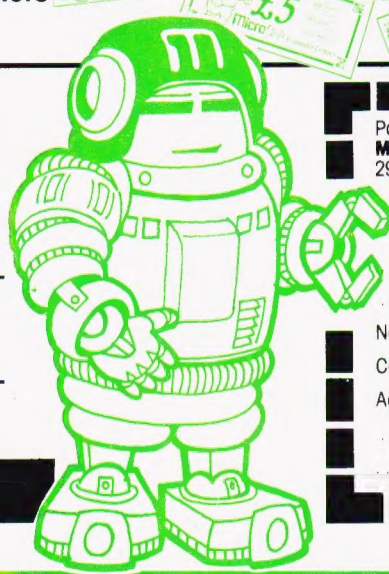

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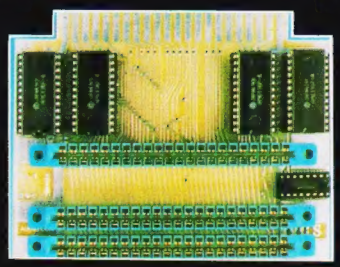

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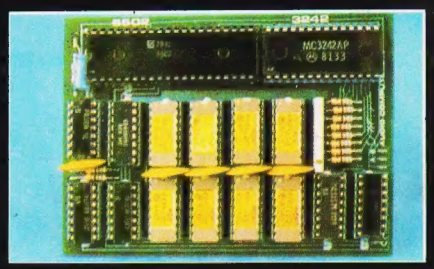

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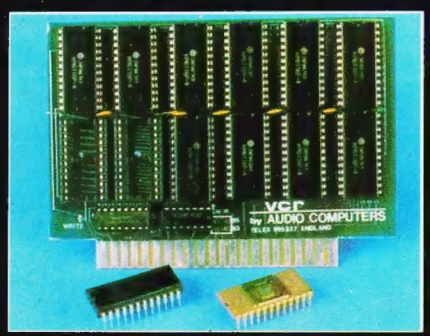

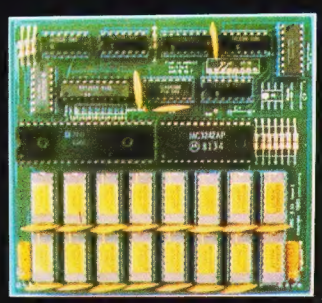

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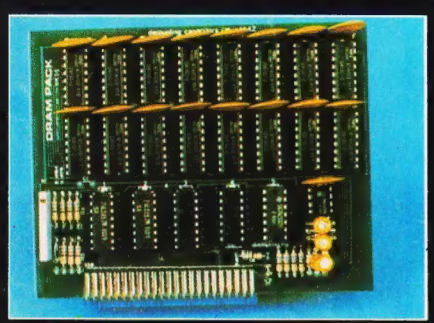

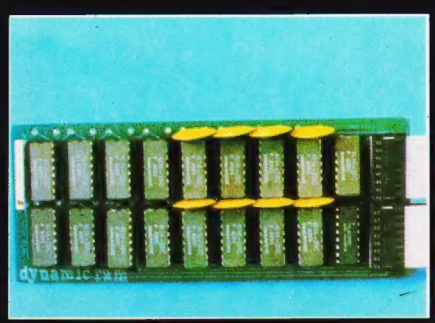

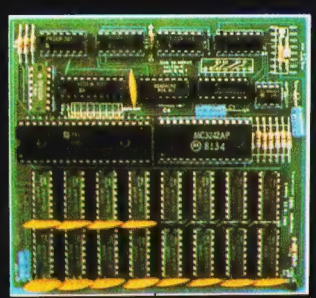

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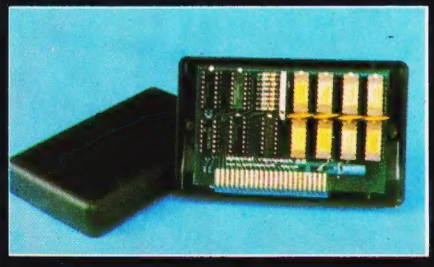

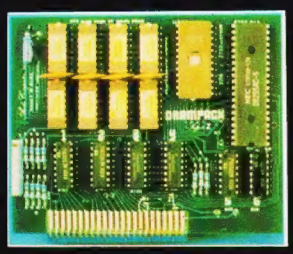

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